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# Children's Knowledge of Temporal Sequences: Spontaneous and Trained Responses

by

(C) Alexandra Kinkaide

A THESIS

SUBMITTED TO THE FACULTY OF GRADUATE STUDIES AND RESEARCH

IN PARTIAL FULFILMENT OF THE REQUIREMENTS FOR THE DEGREE

OF Doctor of Philosophy

IN

Psychology

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THE UNIVERSITY OF ALBERTA

FACULTY OF GRADUATE STUDIES AND RESEARCH

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Date 8 August, 1979

To

Dr. T. M. Nelson

who introduced me first to the intricacies of the topic of time and who has continued to share generously his knowledge.

In appreciation for his help, interest, and guidance when it was needed and the freedom of letting me pursue my own search.

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## Abstract

The study investigates the 6-year old child's ability to show knowledge about temporal order, and the possibility of increasing this ability through training procedures. In order to accomplish this, children who gave *pars pro toto* responses on a verbal pretest were provided verbal feedback relevant to recall and recognition posttests.

Forty-eight (48) children participated. The experimental group was given three days of training. These children showed robust improvement on the recall posttests when feedback was given through training on either recall or recognition. This improvement also generalized to a novel stimuli. Recognition posttests showed no significant improvement.

It is concluded that young children do not report temporal order spontaneously but can do so if they are instructed in this regard.

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## I. Introduction

Time is a major philosophical and scientific concept with a very extensive and complex literature. As one might expect, approaches to the study of time have varied and consequently, as Woodrow (1951) observes, time has been assigned many diverse characteristics, e.g., as coming from within or outside of the person, as being located in heaven or earth, as arising out of biological systems or physical nature, as being real or illusionary, as a priori or a posteriori to man.

There are various explanations and concepts of time. Most explanations, however, have recognized that time is associated with the experience of change, which is related to sequential order and to duration (Fraisse, 1963).

The purpose of the present study is to investigate the ability of children to deal with the first aspect of change, specifically sequential order. Is it possible to increase a child's ability to recall the temporal order of a sequence of happenings through feedback of relevant cues? In so doing, this study has bearing on three developmental areas, namely, (1) acquisition of temporal concepts, (2) memory for temporal order in young children, and (3) concept learning. A brief review of the theoretical and empirical issues as they relate to the concept of time follows:

A. Acquisition of Temporal Concepts

In the psychological literature, time is assumed to be an abstract concept built up through individual and historical experience (Fraisse, 1963; Orme, 1964; Ornstein, 1969). It is viewed as a cognitive construct which does not exist objectively (like a table) or as a quality of an object (as a colour), (Fraisse, 1963; Ornstein, 1969; Woodrow, 1951). Although it is a general attainment, the origins of the concept of time are uncertain. The identification of a biological mechanism for "sensing" time has not been as successful as for other sensory experiences, such as, visual, auditory, taste, or olfactory experiences (Fraisse, 1963; Ornstein, 1969). The laborious search for chemical, mechanical, or neurophysiological structures responsible for the sense of time have, as yet, failed (Ornstein, 1969). It is not even apparent to which area of psychological functioning the experience of time belongs (Frankenhauser, 1959).

We perceive change around us and this seems to have close correspondence to what we call the perception of time (Fraisse, 1963). Nonetheless, although time and change seem closely connected, and much of what we mean by time involves change, our concept of time is more than that of change. It includes the appreciation of duration, past, present, future, simultaneity, and also schemes of temporal organization. The importance of the concept of time for adult persons in our society has been well documented

(Cleugh, 1970; Gurvitch, 1964; Fraisse, 1963; Lewis, 1932; Orme, 1969; Osmond, 1972; Zelkind, 1974). The same is true of the importance of different elements in the life of a developing child (Becker, 1966; Cottle, 1969, 1974; Fraisse, 1963; W. Friedman, 1978; Oakden, 1922; Piaget, 1969; Miller, 1977; Sturt, 1925; Werner, 1946).

The literature on the origin and development of the time concept is extensive, consisting of over 50 studies dealing with various aspects of temporal functioning. But as W. Friedman (1978) points out "to a surprising extent, these studies have been carried out in relative isolation from one another with little interchange on the subject of what are the crucial issues or phenomena" (p. 268). It is possible to divide this literature into three categories; (a) purely theoretical approaches -- those lacking empirical evidence, (b) Piaget's approach, including the enlargement and critical evaluation by Fraisse (1963), and (c) empirical investigations which are not directly related to any particular theory about time. A discussion of literature representing these three approaches follows.

## Theoretical Approaches to Acquisition of Temporal Concepts

Theoretical approaches to the development of the concept of time are neither numerous nor extensive. The few psychologists addressing the problem include Sturt (1925), Piaget (1969), and Werner (1946). The anthropologist Nilsson (1921) also offers an account of the early development of

the temporal notions in the history of man. Psychoanalytical theory, although not directly concerned with the question of time itself, provides another kind of theoretical statement. We shall outline the above-mentioned works briefly. Piaget's theory and its related research are comparatively well developed, and deserve to be discussed separately.

Turning to Nilsson (1921) we find considerable emphasis on the difficulty encountered in identifying origins of time ideas from historical data. Nilsson found direct evidence bearing on early concepts of time to be so limited that he used an ethnological method to analyze time reckoning in existing primitive cultures. The conclusions he drew are tentative, but provocative. He acknowledged that any deduction arising from his method is only indicative of what may have happened.

Nilsson proposes that there are time indications common to all people and that these involve a surprisingly small number of phenomena. He identifies changes in the moon, stars, and sun, phases of nature, variations of climate, as phenomena in which successive or cyclic reoccurrences are recognized. All these are natural phenomena. Nilsson further proposed that primitive man first attends to only <u>one</u> of the specific natural events within a given period and that this event stands for the whole period. Attention to only one event to reckon time he calls <u>pars pro toto</u> time reckoning. In <u>pars pro toto</u> reckoning the period we call 'morning' may be considered as 'milking time' because of the dominant

activity taking place, without any specific or systematic connotation of duration being implied.

A more advanced time reckoning system may, he says, arrange specific activities one after the other as a series without any specific implication being made about duration, e.g., a series can be formed from milking time, watering time, and going to market time. Again, no special system of time reckoning or technical knowledge is needed to conceptualize events in an order. This more advanced form of reckoning is referred to as sequential time reckoning; as such, it is simply a practical system based upon concrete events, similar to that used for pars pro toto reckoning. Such unsystematic indications of time as pars pro toto and sequential reckoning always seem to precede the systematic ones (Nilsson, 1921).

Werner (1946), who is also interested in the cultural and ontogenetic approaches to understanding time, refers to Nilsson's materials. In his studies of language, myth, and religious fantasies of primitive man, he reports finding indications that "time in this primitive sphere is not so much an abstract measure of order as a moment embedded in the whole concrete activity of a social life of a tribe" (Werner, 1946, p. 184). In other words, the primitive man seems to attend to only one event or activity within any particular period of time. He also points out that on the primitive time level, time-reckoning does not deal with much more than a few salient events selected from within

continuous activity. Frequently, systematization of time is intimately connected with important activities of the tribe, e.g., market days, herding days, milking time, or slaughtering days. Such concrete approaches to change appear to hinder adequate development of time measurement because they do not require uniformity and homogeneity of units to be effective in organizing activity. Also, primitive systems of time-reckoning are forms which cannot easily connect distant periods. They fail as complexity of society increases, leaving gaps or leading to overlapping of activity units. In particular they fail to handle multiple sequences, i.e., coexisting series of activities. Pars pro toto and sequential time-reckoning generaly lack that central focus, that continuity and consistency which mark a fully abstract quantitatively determined temporal system.

Werner draws a parallel between the notion of time in primitive man and in young children. Concrete aspects can be detected in the language of children, i.e., one word standing for both present and future activities, temporal ideas being expressed through spatial terms. Adults, of course, confuse space and time too, using terms such as 'small child' and 'young child' interchangeably. Enlarging upon this idea, Werner suggests that the systematization of times does not begin as a continuous, quantitative schema. Rather, he says, the idea of time originates as a sort of ambiguous 'substance' made up of discontinuous pieces having affective as well as concrete qualities. Children slowly

advance from the personal, egocentric concept toward an adult concept of time.

Progress from the concrete to the abstract is slow and gradual. Even in early school years a child uses ego-related concrete situations to designate time, e.g., when children are asked when do they get up they frequently answer "when my mother calls me." They persist in doing this even when they already know how to properly use a clock (Sturt, 1925). Moreover, a child may be able to conceive of time in a general sense so far as his family or immediate surroundings are concerned, and yet be unable to relate time to distant towns and scenes (Sturt, 1925).

Werner's ideas on the origin of the notion of time are a very small part of his theory of comparative psychology of mental development and not completely worked out. Specifically, he does not suggest the nature of underlying mechanisms nor have his ideas been subjected to an experimental test. Nonetheless, cross-cultural and ontogenetic research on this topic (Bohannan, 1953; Bordien, 1963; Geertz, 1966; Lloyd, 1972; Meade, 1968; Shannon, 1975; Uka, 1962) do tend to support both Nilsson and Werner.

Sturt's (1925) book Psychology of Time is devoted to developmental issues. Sturt notes three important components: (a) apprehension of events as having duration and as being temporally extended while retaining their identity -- a concept akin to spatial extension, (b) apprehension that an event has occurred before or after

another event; from such relations the concept of past and future arises, and (c) the experience of different events occurring simultaneously. These components which often appear primitive to an adult are, however, far from being so. In fact, Sturt is able to take these components and to use them to show how development proceeds from primitive rudiments to adult understanding of time.

Adults frequently associate duration with the question "how long?" and thus a reference to a clock or another conventional temporal system such as a calendar is implied. But the experience of duration does not necessarily imply the necessity of comparison with other experiences of duration. The experience of duration need not imply a reference to anything beyond itself (Ornstein, 1969; Miller, 1977). The primitive form of duration is vague and rudiments of it are attached to the intensity of experience, repetition of events such as daylight and night, and other organic sensations such as hunger and its satisfaction. It is from such non-temporal aspects of experience that the concepts of past, present, future, duration, and simultaneity develop and expand into the elaborate structure of conventional time. This development is only one aspect of the organism's complex adjustment to circumstances of life; memory and intention are also significant (Sturt, 1925). The importance of memory is suggested if we imagine how a creature without any capacity to remember would function. Such a creature would be totally reactive and unable to

apprehend any duration.

Sturt's work (1925) provides many ingenious and detailed observations about children's understanding of temporal concepts. Unfortunately Sturt fails to relate her theoretical assertions with the essentially descriptive studies which are reported, e.g., how does the development of the usage of temporal words relate to children's memory.

Psychoanalytically oriented theories stress the function of the ego as the integrator of past, present, and future events of a person's life span. Important connections between feeding, toilet training, and psychological development are stressed. Time development is equated with learning about reality in contrast to adjusting to the "timelessness of the unconscious." Somewhat differently, L. Bender (1906) stressed the importance of the mother-infant relationship on the development of time sense. She did so on the basis of the observation that children deprived of a mother relationship in infancy develop a very poor sense of time. Zern (1970) offers another interpretation of the mother-infant relationship. A cross-cultural longitudinal study supports the suggestion that the extreme opposite in child rearing also plays an important role: strong bonding combined with indulgence leads to an inferior development of a sense of time. Zern says that frustration in a child's environment is a desirable element because it provides a desire to structure his own world objectively. Therefore, it appears that the most beneficial method of child rearing

could lie between deprivation and indulgence, both extremes precluding normal development. Wessman and Gorman (1977) conclude the survey of the psychoanalytical literature on the topic of time as difficult to interpret in a singular way. They say: "... the psychoanalytical account of the genesis of temporal awareness is not consistently formulated and cannot be considered as a well-validated body of knowledge." (page 9).

The Piagetian Approach

Piaget proposes a comprehensive theoretical system tracing the development of the concept of time in children and he supports it with many ingenious experiments. His contribution stems from, and is fully intertwined with, his general theory of cognitive development. It also reflects the philosophical basis of genetic epistemology. While Piaget's work on the concept of time constitutes only a small part of his general theory, he has returned to the problem again and again throughout the last thirty years (Fraisse, 1963). Piaget's views on the nature of time are best described in his book Genetic Epistemology (1970) although one must draw upon his other writings for a complete understanding.

Piaget sees time and speed as being closely related, defining time as the coordination of motions or speed. The most fundamental question for Piaget is which of these notions is the more basic. It is not an easy question to resolve because speed can only be expressed as the

relationship between space and time, and because time can only be measured on the basis of constant speed.

He hypothesizes that the notion of movement, including speed, is the more primitive. He reaches this conclusion by assuming that space is different from, and more basic, than time in several important ways; time is irreversible while space is reversible; space can be considered without content while time is always tied to speed; space can be perceived as a whole (such as a geometric figure) but temporal duration cannot be apprehended all at once. Consistent with this, and from a developmental point of view, he further asserts that durations cannot be estimated until 9 or 10 years of age, while speed can be intuitively apprehended around 5 or 6 years of age. His argument here rests upon results of investigations he and colleagues conducted into the phenomenon of 'passing', that is, when a moving object overtakes another.

Piagetian theory contends that time is a construction based upon the relationship between an action -- something that is done -- and the speed with which it is done. Further, the notion of time is a construction based on operations that are parallel to those of logical mathematical thinking. It follows, then, that the process of acquiring such a notion cannot be completed before the child reaches the stage of formal operations. At this level there are several prerequisites to the measurement of time: (1) an operation of seriation, (2) an operation similar to

transitivity, i.e., if A before B, and C after B, then the magnitude of A C is greater than A B, and, (3) a synthesis of '1' and '2'. According to his theory, only when abstract reversible operations are possible does physically irreversible time become reversible in our thought. This is the final development achieved through use of formal operations.

Based upon these considerations, Piaget provides theoretical guidelines about what a child can comprehend in the stages of development preceding the stage of formal operations. He proposes that the beginning of the acquisition process occurs in the sensory-motor period, which roughly covers the first two years of life. At the beginning of this period the child lacks innate ideas or sense of time and must eventually progress through what is called the 'subjective series.' The child has to become physically involved in temporal ordered events. The child then develops the idea of 'object permanence.' This provides for images of things or events which are not perceptually present, and only after this is attained can he participate in the 'objective series.'

With the acquisition of language the child leaves the stage of sensory-motor intelligence just described. He moves toward the mental representation and enters the 'preoperational stage I.' This stage extends for five years or more, during which simple representations emerge as an articulate intuition. Here the child first represents what

is learned in practical action situations. Following this, the child structures elementary ideas of succession and duration into concepts. Concepts of succession and duration are independent, however, so that the child is unable to infer from one to the other. Spatial and temporal dimensions also are unidentified. Because this is so, time is still localized, varies from motion to motion, and is sometimes confused with spatial order. Even age is interpreted spatially at this point, e.g., the taller child is still considered older. Even when the child knows the order of birth he isn't capable of correcting judgments made on the basis of spatial information. Finally, the child is unable to deduce duration from a temporal order or vice versa. According to Piaget the preoperational child lives exclusively in the present and judges the past on the basis of its concrete results, e.g., growth.

At the substage of articulate intuition, or Preoperations II, the process of decentration prepares the way for organized mental operations and the child finally becomes able to appreciate the inverse relationship between time and speed. When constructing successions, he can respond to intermediate events as well as end points such as beginnings and endings. But these intuitive correlations between duration and succession are still not yet true operations.

'Stage II of concrete operation' is marked by changes in what the child can discover and is able to deduce about

order his knowledge of duration and vice versa. The transition tc Stage II is relatively short and sometimes it is difficult tc pinpoint when it happened. It has been suggested that the stage begins when a child corrects a single error. One may regard that operational time is understood when the child is able to deduce order from colligaticns of durations or vice versa. On a qualitative plane, temporal operations render time homogeneous and continucus and quantitative operations assure that the flow of time is uniform.

Turning to the broader issues, Piaget believes that psychological time is constructed by the same operations that are involved in structuring physical time. The relationship of psychological time and physical time are considered to be obvious and not to require elaboration. What is not clear to the critic, however, is the way in which physical time implies psychological time. It seems likely that any succession of psychological phenomena may only be grasped by an observer who goes beyond physical events and who is able to reconstruct a physical time which exists only in memory. However, it is sufficient for Piaget that physical and psychological time are closely related and that both are alike in that they involve the causal order of events.

The most comprehensive review and evaluation of the philosophical dimensions of Piaget's work is offered by Fraisse (1963). Fraisse draws heavily on various ideas,

experiments, and stage constructions of Piaget throughout his book, Psychology of Time. However, he expresses some very basic and significant reservations about the theory. Fraisse points out that Piaget's interest in the topic appears to stem from Einstein's question to him of whether the subjective intuition of time is immediate or whether it is derived, and whether the subjective intuition is integral with speed from the first. Fraisse suggests that Piaget became preoccupied with time in relation to speed. Fraisse further suggests that Piaget was largely attuned to situations in which the time = distance/speed relation is apparent from the very beginning. Certainly, Piaget affirms that the notion of time takes shape only when there is the first articulate intuition of the invariant relation of speed and duration. He deals with this problem in many of his experiments.

Fraisse (1963) differs with Piaget over the question of the nature of the basic intuitions the child possesses. For Fraisse they are those of space, speed, and duration. He sees the latter as an elementary form of experience, as that experience which connects the child's needs with need fulfillment. Even more directly for Fraisse, is the supposition that representation of time exists independently of speed and can be apparent before the operational stage is reached.

Fraisse's disagreement points to a certain inconsistency in Piaget's writing. Piaget refers in

different places to the topic of time. While he presents some very loose descriptive and situational evidence to support the idea of a sensory-motor level of cognitive develcpment, one gets an impression that the child has some scrt of sense of time and duration by the end of that period. Indeed, it could be argued that the ability to wait, for example, implies apprehension of duration, however vague. The child's ability to use temporal words too, such as a correct past tense, also presupposes some knowledge or intuition of time (Miller, 1977). However, when Piaget leaves discussion of the sensory-motor period, he starts tracing the development of the concept of time with respect to space and speed while disregarding the child's previous accomplishments. Flavell (1963) asserts that Piaget drew heavily on parallels with other concepts such as development of permanency of objects and space. He suggested that in this area of writing Piaget seems to tolerate an unusual amount of ambiguity and 'shaky conjecture' in order to gain some elementary understanding of temporal phenomena, especially in the period of infancy.

Piaget's work stands as the most extensive theoretical work dealing with the development of the concept of time in children. It is thus rather surprising that his work has generated relatively little empirical research. Moreover, several studies which do deal directly with this aspect of Piaget's theory have been inconclusive. The findings of one study (Lowell and Slater, 1960) which investigated

synchronous intervals and order of events, replicated Piaget's data. However, a study by Cromer (1971) yielded results which do not support Piaget's theoretical predictions as to the age at which children temporally decenter. This study found that temporal 'decentration' is achieved by the age of six years, while Piaget and Inhelder (1958) claim that children do not decenter spatially before seven or eight years. This is a serious inconsistency when one recalls that temporal decentration should not be accomplished before spatial decentration in terms of Piaget's theory, since space is a more basic notion than time. Some of the other theoretical predictions related to the order of acquisition did not receive support in a study reported by Brainerd and Weinrebe (1975). The latter research was designed to test aspects of Piaget's groupment theory, using the concept of time and speed. It showed that the molar concept of time and speed can be grasped before their postulated precursors, e.g., temporal order, temporal interval.

By pursuing the relationships between speed and time, Piaget may have neglected other important forms of children's understanding of temporal ideas and as children's ability to respond to, and finally appropriately use, temporally related commands, e.g., "wait a minute", "come back later", etc. By inquiring exclusively into the relationship between speed and time, the broader perspective of what the child is able to do and with it the unique

features marking understanding of particular ages.

Historically and culturally the clock is not the only means used to deal with time, as Werner and Nilsson show. Ornstein (1969) has questioned whether the emphasis and effort that has been paid to the question of how man estimates clock time has not been misdirected effort if one wants to gain a deep understanding of temporal experience. This question is pertinent here because Piaget is mainly interested in the concept of time and its development, as defined by temporal homogeneity, continuity, and uniformity, i.e., Piaget centers his attention on the prerequisites for awareness of clock time. It is true that in order for a child to be able to measure time he has to apprehend the relationship between time and constant speed. However, as important an achievement as this is to the final intellectual outcome, it has comparatively little importance for children of younger ages. It has been established (W. Friedman, 1978; Wallace and Rabin, 1960) that by the age of 9 or 10 years, the age that Piaget sees intuition of duration, a child has covered much ground and adapted rather well to his temporal environment and the associated social and cultural standards. In spite of the child's well documented (Friedman, 1978) relative adjustment to the temporal dimensions of his daily existence and the sophistication of his temporal language, he is still, according to Piaget (1969), more than four years away from "true conceptualisation of time." By this Piaget means that

a child has not developed a reversible schema of time, i.e., he cannot coordinate events in reference to speed. Whether or not this is as exclusively important as he asserts remains a theoretical as well as empirical question. Consequently, considering the paucity of empirical research and theoretical issues neglected by Piagetian theory, more critical re-evaluation of Piaget's work on time is needed.

## Empirical Studies Related to Temporal Aspects of Language

Besides the theories and research discussed above, there are other inquiries which do not directly stem from the above discussed theories and which are often not directly related to each other. For example, studies of language contribute valuable information about various aspects of children's understanding of temporal concepts and relationships.

The acquisition of language is important because it enables a child to substitute words for objects and actions. In this way the child's dependence on the immediate physical world is lessened: the child can use ideas as a means of organizing behavior in the absence of concrete stimuli. It seems likely that the emergence of the child's language and the acquisition of semantic and cognitive development are closely related.

Numerous studies of children's concepts of time deal with the developing ability tc spontaneously use and comprehend temporal words (Ames, 1946; Clark, E., 1973; Clark, H., 1973; Harner, 1975, 1976; Hitch, 1973; Lewis,

1975; Sturt, 1925). Frequently the first words refer to the "here and now." Only later do children use symbols expressing abstract states which function as representations of sequences of actions and events (Stevenson, 1972). Around the second year, children start to use words to provoke desired behavior in others (Lewis, 1937).

Much is known about the child's ability to use and understand temporal words. Developmental studies (Ames, 1946; Bateman, 1969; Bradley, 1947; Harrison, 1934; Oakden and Sturt, 1922; Schechter and Symonds et al. 1955; Stone, 1971; Sturt, 1925) dealing with this subject generally point out that verbalizations about time occur in an orderly sequence, emerging at the same relative period in each child's development. The order in which temporal expressions occur suggests progress from words which are activity centered -- always including external factors -- to words indicating awareness of universal rhythms, thence to understanding of terms expressing conventional and historical conceptions of time, and finally to words indicating accurate time estimation. Complete mastery of any group of words is not achieved at once, and thus the development does not appear to be stage-like. The child initially reacts to a word correctly by responding (e.g., waiting). Later a child may react by using the word spontaneously and then, finally, by responding with the correct word when asked a question (Ames, 1946; Bateman, 1968). The development of temporal expressions is a slow and

gradual process which extends into adolescence (Wallace and Rabin, 1960). Also, considerable individual differences have been noted (Ames, 1946).

Recently, a number of studies and hypotheses have emerged about the nature of children's acquisition of semantics. Some papers (Barrie-Blackley, 1973; Clark, E., 1970, 1973; Clark, H., 1973; Friedman and Seely, 1976; Harner, 1975, 1976; Hirtle, 1975; Hirch, 1973; MacDonald, 1972; Miller, 1977; Weil, 1969) are specifically directed to the matter of acquisition of verbal time concepts, e.g., past, present, and future verbal tenses, as well as such terms as "before" and "after." A few tentative generalizations come out of this research. For one thing, temporal terms appear to be learned on the basis of spatial terms, which precede them and which, in turn, are predicated on knowledge of perceptual space (H. Clark, 1973). It also appears that early meanings are derived from immediate perception and only later do children learn the role these words play in diverse contexts (E. Clark, 1970, 1973).

No general statement can be made about the age at which a child first understands and makes meaningful reference to time expression, for example, reference to future or past events (Harner, 1975). Also, one finds a child's speech is closely related to the behavior context in which it is embedded. It has been shown that adult conversations greatly influence a child's references to past and future by drawing a child's attention to relevant events which have

ocurred or things which are expected to happen. Furthermore, when adults clarify and correct children's usages, they reinforce appropriate references to time (Lewis, 1937). These latter two points should be kept in mind when one considers the rationale for the training procedure in the present study.

B. Memory for Order

It has always been assumed that memory in general is fundamental to acquisition of any temporal relations (Flavell, 1970; Fraisse, 1963; Ornstein, 1969; Sturt, 1925). Until recently it was thought that children's memory for temporal order is poor, developing slowly throughout childhood and into adolescence. For example, Piaget (1962) and Fraisse (1963) both report that the 6- to 8 year-old child, when recalling stories, fails to respect temporal order and tends to jumble sequences of events, and confuses cause and effect relationships. The temporal inversions were thought to be due to a failure to comprehend chronological, causal, and deductive relations. Piaget says that these relations, as well as the reconstruction of order per se, involve the "reversibility" of operations and accordingly can not be mastered by the preoperational child. More recent research (Brown, 1975; Mandler and Johnson, 1977) does not suggest that children have such memory limitations. A child's ability to remember the order of events implies an ability which is much more pervasive than

Piaget assumes, and this ability is revealed with more sensitive tests.

In general, memory can be tested through use of three different methods of test -- recognition, reconstruction, and recall. The last method presents the greatest difficulty regardless of age. Therefore, children recognize temporal order before they can reconstruct it (Blackstock and King, 1973; Brown, 1975; Halperin, 1974), and both these tasks are easier than, and thus developmentally precede, recall of temporal order. In addition, recognition of specific items, presumably the basis for pars pro toto time reckoning, is always found to be superior to recognition of temporal order -- being, of course, a simpler task, not one involving relations between elements (Brown, 1973). So far as recognition of specific items is concerned, young children show approximately the same ability as adults (Brown, 1971).

Children's recall shows more obvious developmental trends. One study (Rossi and Rossi, 1965) reports that a majority of subjects younger than 4 years who served in an experimental study of recall of serial order did not spontaneously use order to organize their reports. On the other hand, Brown (1975) found that kindergarten children, when instructed regarding the sequentiality of successive items, did approximately as well as older children. She concludes that only when order is an inherent part of the information which is required to be processed will it be

retained by the young child. Subsequently, Brown, Smiley et al. (1977) also reported a striking absence of developmental trends in children's recall when meaningful prose passages were used. Both studies indicate that organization or meaningful referents are important for children as well as adults.

Not surprisingly, Brown (1975) found that kindergarten and second grade children recall the order of events better when they are part of logical and self-composed forms than they do when they are faced with arbitrary arrangements. Second graders do recall order and reconstruct order in approximately the same way. Brown interprets the outcomes of her research by saying "failure of the preoperational child to maintain the correct order when retelling a story stems from a general problem with recall tasks and immature expository powers rather than from an inability to comprehend and remember the ordered relations in sequences" (p. 63).

Results from a study by Mandler and Johnson (1977) are consistent with these conclusions. It was found that recall tasks generally pose considerable difficulties for young children, and that correct temporal ordering depends upon the degree of structure in the presented stimuli. A surprising finding is that events, if they are recalled at all, are reported mainly in correct temporal order. The importance of structure is supported by the fact that well structured stories led to superior recall so far as order

was concurred. This was true for all age groups tested, including 6 year-olds. This absolute level of sequential ordering was extremely high for all the groups tested for recall of well structured stories; first and second graders did as well as university students.

It thus appears that even very young children have some concept of temporal order insofar as they are able to recognize and then reconstruct order at early ages. Recall seems to be guided by principles similar to those employed by adults. It is found to depend on such variables as structure, meaningfulness, organization, 'surprise value' (Beaver, 1970; Brown, Smiley et al. 1977; Kintch, 1976; Kintch, Kozminsky et al. 1975; Mandler and Johnson, 1977), as well as the method of testing used. One might conclude that children can, and do, spontaneously recognize and reconstruct order before they can spontaneously recall it. Even though a young child may not spontaneously recall order, this child can often do so under favourable circumstances even at 4 years of age.

## C. Concept Learning and Children's Apprehension of Temporal Concepts

Stevenson (1972) points out that we have a great deal of information "about when children manifest certain concepts but only a limited understanding of how concepts are learned."

Piaget's interactionistic stage theory of cognitive

development at present provides the starting point for research in children's concept formation. Until very recently, research was preoccupied with examination of Piaget's theory. However, new research is required to broaden an understanding of concept development as related to time experience, a matter comparatively unexplored. An objective of this investigation is to determine whether it is possible to facilitate children's recall of temporally ordered stimuli through use of feedback.

Piaget's basic assertion is that cognitive development is the product of an interaction between experience and maturation; self initiated activity is deemed the most important prerequisite for concept attainment. The possibility of accelerating concept formation through training appears to have been of little interest to Piaget, and his theory would predict that such training should be minimally effective, and perhaps even dangerous (Brainerd, 1978). Stevenson (1972), though, emphasizes the importance of research to test the possibility of accelerating concept formation "because to the degree that positive results are obtained Piaget's theory is weakened" (p. 93). In addition, positive results may allow us to infer processes by which children learn concepts, processes which may be more efficient than self-discovery and the vague adaptions suggested by Piaget.

Several articles suggest that concepts can indeed be trained (Brainerd, 1976; 1978; etc). For example, Gelman

(1969) in a training study on conservation acquisition of 5-year-old children, found support for the idea that "young children fail to conserve because of inattention to relevant quantitative relationships and attention to irrelevant features in classical conservation tests" (p. 186). Gelman also found that feedback is a very important part of training procedures because it informs the subjects as to what is and what is not relevant in a given task. Similarly, Wallach, Wall et al. (1967) suggest, on the basis of their research, that conservation depends upon whether a child can learn to ignore misleading cues. Miller and colleagues (1975) also conclude from experiments into conservation learning that children must decide which of the present cues are relevant to the apprehension of the concept of quantity. Molly and Jeffrey (1974) who studied the effects of organization training on children's free recall of category items, found that 6-year-old subjects "can be taught to use an organizing technique in such a way that it will be used with new sets of items" (p. 142). Instructions emphasizing what to look for and what categories to use had enhanced the total recall scores.

Research into training children's temporal concepts has yielded some significant results which are of interest here. Several studies have demonstrated that children may be taught temporal words (Amidon, 1972; Becker and Gonther, 1966; Dutton, 1967; Kelty, 1925; Lewis, 1937) and that understanding of chronology basic to social studies

(Arnsdorf, 1961; Benoit and Valeno, 1962; Dutton, 1967; Friedman, 1945; Pistor, 1940; Stone, 1971) can be improved. Awareness of time and duration (Crowder, 1970; Hermelin and O'Connor, 1971; Levin, 1977; Orsini, 1963) can also be increased by proper techniques of instruction.

Dutton (1967) has been able to significantly increase the understanding and awareness of temporal concepts by culturally deprived children in primary schools through 5 weeks of daily instruction. Dutton stresses the importance of training children to attend and respond to temporal dimensions. He concludes the "Primary age children left to their own activities and needs will neither use time a great deal nor master the ability to tell time" (p. 363). Likewise, Friedman (1945) finds that systematic instruction significantly increases students' appreciation of time in history classes. Arnsdolf (1961) has achieved similar results with sixth graders through 7 weeks of instruction relating to chronology. The research of Bradley and Hundziak (1965) and Benoit and Valeno (1962) demonstrates that retarded children can be helped to understand and appropriately apply temporal concepts through the use of instructions initially designed for normal children.

Consistent with results reported in the above-discussed studies, as well as conclusions drawn from conservation studies, Hermelin and O'Conner (1971) find that children do not spontaneously orient towards temporal dimensions of stimuli but rather select out spatial dimensions. They were

also able to increase attention to the temporal dimension after being given specific instructions to do so. Similarly, Amidon (1972) demonstrated that 5-year-old children provided with verbal feedback show rapid improvement in the correct usage of the words "before" and "after". It was concluded that information about the importance of temporal ordering is of critical importance to satisfactory performance. Levin (1977) concludes that "the children's conceptions of time are basically temporal but are vulnerable to counter suggestions from various factors including spatial variables." (p. 443)

One of the most striking features of the positive results achieved in concept learning experiments is the comparative ease of acquisition, as indicated by the brief instructional techniques. In some cases the effects of verbal training indicate robust and permanent concept acquisition, as measured by tests for concept generalization and long-term retention (Brainerd, 1978). These results challenge early conclusions about children's inability to benefit from specific instruction and raise definite possibilities with regard to facilitating time concepts.

In sum, the positive results arising from training in concept formation point to the conclusion that even young children can learn concepts previously thought too difficult, and that they can benefit greatly from specific instructions. Instructions seem to be successful when they serve to make a child aware of, and attend to, relevant cues

in a given learning task. Feedback techniques such as those commonly used in successful instructional studies, help the child to identify the correct stimulus dimension.

## II. Present Research

The present study draws on research previously reported by Kinkaide (1973) and Nelson (1968). In those studies Nilsson's (1921) and Werner's (1946) observations about time notions held by primitive man were applied to children's understanding of temporal relations. Results showed marked similarities to the primitive form. These suggest that the first indications of time awareness in children may be associated with perceived sequences of disjunctive change rather than with perception of coordinations of movements, as argued by Piaget (1969).

The study by Kinkaide (1973) was cross-sectional and involved children from 5 to 16 years of age. Several abilities to identify temporal change were isolated. First, the majority of 5- and 6-year-olds identified only one event when asked to give a verbal representation of the perceived interval. The events were not representations of the major theme -- were not abstractions -- but were events arbitrarily chosen from the array of things seen in a movie. The reported events did not follow the law of recency. Thus, the responses were pars pro toto (PPT), in form. Second, at the age of approximately 9 years, most children spontaneously reported two or more events that happened in the given film in their correct temporal order. At this age, however, the children did not demonstrate an ability to give accounts of two series going on simultaneously. In other words, they identified linear order correctly, but not

the multiserial nature of the stimuli when it was relevant. Third, it was not until the age of 12 that the majority of children arranged their experience of the film into an appropriate multiple series. The method of free recall was used throughout to obtain children's responses.

These data were replicated in a later study (Nelson and Kinkaide, 1976) which, in addition, determined that first and 3rd graders respond in the PPI way to films regardless of thematic content (e.g., comedy, conflict, adventure, etc.).

It is apparent that children initially cannot or do not spontaneously attend to, or are not aware of, the relevance of the temporal organization in a stimulus sequence. This generalization gains some support from the results of the previously mentioned study reported by Hermelin and O'Conner (1971) which shows that children attended spontaneously to spatial and not to temporal dimensions present in short meaningless stimulus sequences. Taken together, these experiments suggest a different interpretation of Piaget's (1969) experiments. In his experiments, children were exposed to irrelevant and misleading spatial cues which might have taken precedence over temporal cues. Because of this peculiarity, particular abilities in temporal relations of Piagetian children may have been masked.

Consequently, in agreement with some of the recent studies in conceptual learning (Brainerd, 1978; Siegal, 1978) it may be expected that when children are made aware

of, or directed to attend to, the relevant dimension of the given stimuli, they can learn to identify temporal relations correctly. Other evidence, too, suggests that although average 6-year-olds do not actively represent temporal dimensions in their verbal reports, they can recognize or appreciate temporal organization if they are presented with a test which is easier for them and hence more sensitive to their potential for temporal order, i.e., a recognition test (Brown, 1975).

The proposed research was designed to investigate several related issues. Based on previous studies (Kinkaide, 1973; Nelson, 1968; Nelson and Kinkaide, 1976), groups of first graders known to respond in PPT ways were chosen to participate in the experiment. It was proposed to facilitate the development of their ability to deal with change in temporally ordered ways by pointing out relevant cues, i.e., children responding in a PPT way are submitted to treatment conditions involving verbal feedback. To the extent that feedback is successful, children should report temporal sequences.

The following hypotheses are formulated:

1) A majority of first graders respond in a pars pro toto way to filmed sequences on an initial recall test. This prediction is consistent with previous findings.

2) Significantly more first graders are able to recognize temporal order using a recognition test than they are using a recall test of memory.

3) Significantly more children report sequences in contrast to single events (*pars pro toto*) immediately after having been given feedback of relevant cues for temporal order.

4) Repeated feedback of the relevant cues for temporal order leads to a relatively permanent improvement in the manner of reporting sequential visual stimuli. Such a change is considered evidence for a facilitation of knowledge of temporal order.

## III. Method

### A. Subjects

Sixty-five (65) Ss attending first grade at St. Albert Lacombe Elementary School, St. Albert, were pretested. Forty-eight (48) of these were chosen to serve as Ss using criteria to be described. Mean age was 6.1 years, and ranged from 5 to 7. Males and females were tested. Children with known learning disabilities or severe behavior problems were excluded.

### B. Materials

#### Recall

Three-minute excerpts from five silent films to be identified as A, B, C, D, E, were chosen as stimuli. The excerpts approximated situations that children encounter in their daily lives: they were continuous, meaningful, and comparatively long temporal sequences. The stimuli were well-structured, interesting, and nonthreatening. Because stimuli were selected in this way, little attention was paid to the detailed properties of the stimuli. They had the advantage of being a familiar mode of representation for children accustomed to watching T.V. By presenting age-appropriate and interesting stimuli, it was expected that attention could be sustained and anxiety minimized. Furthermore, the effects of the differences between the structural and thematic content were minimized by presenting

the children with different films at random order for each S during the training part of the experiment.

The excerpts were taken arbitrarily from 10-minute films and did not include either the beginning or the end of these films; i.e., although the excerpts represented meaningful sequences suggestive of a story, they did not specifically represent a complete story with a designated beginning or conclusive end. This reduced the likelihood of having highly dominant elements which might favour PPT reports. The five excerpts were videotaped from Super 8-mm film and then displayed on a standard video monitor screen. Care was taken to assure that the children had a good view of the screen.

All the films featured characters played by child actors which were involved in different "make believe" adventures. A brief description of each film excerpt follows:

Film A

The excerpt was taken from "The Little Rascals - Haunted House" silent film. The excerpt was made of discontinous episodes portraying the adventure of three boys in a carnival spook house. They encountered several surprising events such as seeing a devil, a monster, or skeletons unexpectedly falling down a slide, and finally escaping the haunted house.

Film B

The excerpt was also taken from "The Little Rascals

- Haunted House." The story was made of an episode that preceded that of A. In this sequence, three boys are watching a parade with clowns when they notice a truck loading large boxes. They then get inside one of these boxes, the truck starts to move, and the boys find themselves in an unknown house. They try to determine where they are but encounter a strange-looking record player. They run into a hallway where they meet a monster.

Film C

The excerpt was taken from "Pie Covered Wagon" featuring Shirley Temple. It was essentially a film about a war between cowboys and Indians in which a number of episodes happened, e.g., the cowboys were attacked by Indians, the girl got caught by Indians and tied to a tree, cowboys tried to free her and they sent a dog with a letter to a fort, the dog couldn't get in because the gate was closed, the boy who was watching the fort was asleep, and finally the dog jumped over the wall and delivered the letter.

Film D

The excerpt was taken from "The Little Rascals - Spooky Hooky" featuring four boys going into an empty school-house. There were many unexpected events that ensued: it was raining and storming, the boys were looking for shelter, they encountered a school caretaker and ran away from him, they got inside the school and

met a teacher, they were pretending they had a note to deliver, and they were pretending to sneeze, they tried to steal a paint, they opened a door of a closet and found a skeleton, and finally they were very scared and they run away.

Film E

The excerpt was taken from "Kid in Africa" featuring Shirley Temple and Tarzan. The girl was taken into captivity in a jungle, and she was going to be eaten by Indians, they were dancing a war dance, girl was crying for help, Tarzan heard her and was trying to reassure her, he jumped on an elephant and finally rescued her before she would have been put into a boiling pot of water.

Recognition

Three 10 X 10-cm photographs (a, b, c) were taken of significant events (as determined by two adult judges) from each film. Two randomly determined sequential orders, plus the correct one, were taken from the set of six possible combinations. These three series were fixed to a 35 X 40-cm piece of cardboard paper and served as stimuli for the recognition test.

C. Experimenters

Two female experimenters were present thoughout the study in order to assure efficient recording of responses. One experimenter attended to the projection of the films and

the other, who was a trained teacher, provided verbal instructions and feedback. Each experimenter recorded the responses of the children who were assigned to them every day on a randomly determined basis.

D. Procedure

Pretests

Recall Pretest

The intent of this test was to identify children who spontaneously deal with presented stimuli in a PPT way, i.e., Ss who attended to only one event, from those who gave a serial or sequential (SQ) description.

Ss were tested individually. All were instructed as follows, then shown film A. These instructions were used throughout all phases of this experiment:

"I will show you a movie now. I want you to watch very carefully and pay close attention so you can tell me later what it was all about and what happened. When the film is finished we shall ask you some questions." The film was then shown. Immediately afterwards each child was questioned. One of the Es asked and recorded the response to the following question:

"Can you tell me now all that happened in the movie?" No further inquiry was made about the film; the name, age, and child's classroom were also recorded.

Recognition Pretest

The presentation of this test always followed the

Recall pretest. This pretest was included to corroborate that the recognition test is more sensitive and thus reveals more information about children's understanding of temporal ordering than recall tests (Brown, 1975).

Three sets of three 10 X 10-cm photographs (a, b, c) containing significant events from the film A were presented to all Ss after the completion of the Recall pretest 1. The three sets contained one correct sequence and each sequence was arranged spatially from left to right. The following question was asked:

"You see these pictures? They are photographs of some of the things that actually happened in the movie. Do you remember them? Good. Now I want you to look at them carefully and tell me if in the movie they happened in this way (pointing to the first series) or this way (pointing to the second series) or this way (pointing to the third series). Show me which way it did happen." Responses were recorded as right or wrong.

E. Evaluation of Responses

Recall Pretest

Film A

All written responses were classified into three categories.

1. No response -- no descriptive material elicited through the question other than a statement from S that

he cannot remember anything of the story or S gives an irrelevant response, e.g., "I like movies", "I don't know", etc.

2. Pars pro toto (PPT) response - was considered to be a concrete description of a single event or action which occurred in the film. Response was scored PPT when the child reported one salient event which was chosen from the viewed series. Shortness or longness is not the relevant dimension of the PPT response, but ordinarily PPT responses are shorter. These responses, in general, do not give an indication that the child was aware of, or trying to relate to, the temporal order of the events which happened within the film. The described episodes are isolated and no consideration is given to their temporal position within the interval. Abstractions based on the child's understanding of the thematic content of the film were not classified PPT. Such an abstraction could have been formed on the child's integration of the sequence of events that took place in the film, e.g., "The film was about Shirley Temple getting into all sorts of troubles" (Film E), "The film was about the war between cowboys and Indians" (Film C), etc.

Examples of typical pars pro toto (PPT) responses:

"They saw a devil." (Film A)

"They opened a door." (Film B)

"Cowboy girl was tied to a tree." (Film C)

"Boy put the sheet over his head." (Film D)

"Tarzan jumped on the elephant." (Film E)

3. Sequential Response(s) (SQ) -- Two or more concrete events from the film are accurately ordered into a sequence. Responses were judged to be sequential regardless of how many events were recalled if they complied with the above. The following are examples of SQ responses:

"They were running on a mat and they fell down, and they saw the devil and the chair came out and they ran out of the house." (Film A)

"They got into a box and the car got going and then they saw a scary thing." (Film B)

"Indians chased people and they were dancing and girl was crying and cowboys sent their dog with something on his collar." (Film C)

"Four boys and it was raining and they came in and then man came and they tried the door and they saw a teacher and were sneazing and then they ran and they opened closet and saw skeleton." (Film D)

"Lady came, then two Indians watched her, and they captured her and they were going to make a stew, they tasted it and Tarzan saw it and hollered and the elephant came and Tarzan rode it, and Indians called another Indian on the phone." (Film E)

Assignment to groups

Forty-eight (48) Ss reponding PPT were randomly

chosen from the total of 52 Ss responding PPT. Twenty-four (24) of these were assigned to the control group and 24 to the experimental group on the following basis:

(a) Each of the two groups, i.e., control and experimental groups, were comprised of 12 Ss who were able to recognize the correct temporal order on the Recognition pretest and of 12 Ss who were not able to recognize the order on the Recognition pretest.

(b) The control groups were divided into two subgroups of equal numbers. One subgroup (set 1) was exposed to the recall test only throughout the 3 days of training and the other (set 2) to the recognition test only throughout, but neither set received feedback.

(c) Experimental groups were also divided into two subgroups of equal numbers. One subgroup (set 3) received feedback on recall only and was tested only on the recall test. The other subgroup (set 4) received feedback on recognition only and was tested only on the recognition test.

Experimental Condition

Ss in the experimental group (sets 3 and 4) were shown different films on each day. The order of presentation was randomly determined for each S. After the end of each film the Ss assigned to set 3 were tested on the recall test and immediately given feedback in the following form:

"The film we have seen today was about ... (here seven significant events were reviewed in the actual order that they happened in the film). There were several important and interesting things that happened. I am going to tell you about them in the ORDER that the things actually followed each other; at first ... (here seven events from the film were related again, using words connecting as "and then after that ..."). This was the Order in which things did happen. I will tell you again (shorter repetition followed). Now tomorrow we shall see another film and I shall want you to tell me about it in the order in which things happen one after the other."

Experimental set 4 received the following feedback after viewing each film:

"That's right (or wrong). This is the ORDER in which the things happened.

First ... (description of the first photo), then ... (2nd photo), and then ... (3rd photo). That is the ORDER, one thing happens after the other (the feedback was repeated once more). Tomorrow we shall see another film and I want you to show me afterwards how things happened, in what order they happened."

Control Condition

The Ss were instructed as above before seeing the film. Afterwards Ss in set 1 were tested on recall only, and Ss in set 2 were tested on recognition test

only. At the end of every session control Ss received no feedback but were told that they would see another film and be involved in a similar task on the next day. The time spent with control Ss was not very different from the experimental groups since there was informal conversation in both cases after the experiment to maintain interest and rapport.

Posttest Condition

The procedure was identical to that of the pretest condition:

Posttest 1

On the fifth day of the study all Ss saw film A with an identical procedure as used in Recognition and Recall Pretests. Thus, all Ss were asked to give both a recall and a recognition response. Feedback was not provided.

Posttest 2

This posttest was identical to Posttest 1 but was given one week later, i.e, Ss saw the film A with no feedback. This posttest was given in order to determine whether the mode of responding produced by instructors was retained in the response repertory of the child. Retention was interpreted as evidence of a relatively permanent change in behavior (i.e., learning).

Posttest 3

Immediately after completing Posttest 2, Ss were told that they would see another film (E). The same

instructions were given. Film E was new to all the Ss. Recall of the film was recorded but the recognition test was not given because this posttest was included ad hoc and at this point the recognition materials (photographs) were not available. The test was included as an afterthought to discover whether or not the learning would generalize to an unfamiliar film.

## IV. Results

### A. Pretests (Test of Hypotheses 1 and 2)

Table 1 gives frequency distributions of responses to the Recall and Recognition pretests. A chi-square one-sample nonparametric test (Siegel, 1956) was employed to test Hypothesis 1. Results of the test show that significantly more subjects gave PPT responses than SQ responses on the Recall pretest, $\chi^2$ (1) = 14.22, $p < .01$, supporting Hypothesis 1. The majority of the responses of these children were PPT.

Results are in accord with previous findings (Kinkaide, 1973; Nelson, 1968; Nelson and Kinkaide, 1976). Frequencies of responses for data collected on the Recall pretest in the present study and frequency of responses reported in the study conducted in 1973 are shown in Table 1. A chi-square test does not indicate significant differences in the distributions of the responses when data from these two studies are compared. Notice that approximately the same ratio of Ss responded in PPT way in both studies. Replication of the previous PPT effect is therefore indicated.

The outcome of a chi-square test provides support for Hypothesis 2. Significantly more Ss were able to recognize temporal order on the Recognition pretest than were able to recall it on the Recall pretest, $\chi^2$ (1) = 6.50, $p < .01$.

B. Posttests

Frequency distributions of responses for recall and recognition tests across days are shown in Fig. 1, 2 , 3, 4, and 5. The actual frequencies are given in Table 2. These presentations are provided for the general information of the reader.

C. Effects of Exposure Alone

The McNemar nonparametric statistical test (Siegel, 1956, p. 63) was used to test for the significance of response changes and, more specifically, to examine the effects exposure to the films, experimenters, and situation have on Recall and Recognition posttests. All relevant pretest-posttest comparisons lead to nonsignificant results. This suggests that without specific intervention, Ss of this age do not spontaneously abandon the PPT way of responding.

D. Effects of Training (Test of Hypotheses 3 and 4)

Effects of training were assessed by applying McNemar's test in all but those instances when the expected frequencies were very small (less than 5), in which case the binomial test was used (Siegel, 1956 p. 36). The effects of training on recall and on recognition through the use of feedback were tested separately.

Pretest-Posttest Comparisons

Statistical comparison of compound data between the Recall pretest vs Recall posttest 1 yields significant results, $\chi^2$ (1) = 17.11, $p < .01$. However significant effects were not found in a Recognition pretest vs Recognition posttest 1 comparison. These results indicate that training leads to a significant improvement on the recall test when there is feedback on recall; i.e, Ss improve in their ability to relate perceived events in sequential (SQ) order.

Recall pretest vs Recall posttest 2 comparison reach significance too ($\chi^2$ (1) = 21.00, $p < .01$). Apparently Ss retain improvement in their ability to recall sequential order after one week of rest. This attests to the robustness of the learning.

Furthermore, a comparison between the Recall pretest vs Recall posttest 3 is significant ($\chi^2$ (1) = 21.62, $p < .01$), suggesting that the sequential response form were generalized to a novel film. Apparently verbal feedback on recall is very effective in improving a child's ability to report sequential order.

Similar training through feedback did not lead to significant improvement on either Recognition posttests 1 or 2. This failure to improve recognition response through feedback will be discussed later.

Data were further analyzed to permit four other comparisons to be made; namely,

i) effects due to training through feedback of recall on Recall posttests 1, 2, and 3.

ii) effects of training through feedback of recall on Recognition posttests 1 and 2.

iii) effects of training through feedback of recognition on Recall posttests 1, 2, and 3.

iv) effects of training through feedback of recognition on Recognition posttests 1 and 2.

Significant results were obtained for the following comparisons, "a", i.e, effects of training recall on Recall posttest 1, 2, and 3, $\chi^2$ (1) = 8.10, $p < .01$, $\chi^2$ (1) = 10.08, $p < .01$, $\chi^2$ (1) =10.08, $p < .01$, respectively, "c", i.e., effects of training recognition on Recall posttest 1, 2, and 3, binomial $p < .01$; $\chi^2$ (1) = 9.00, $p < .01$, $\chi^2$ (1) = 9.00, $p < .01$, respectively.

These results indicate that the information received through feedback on recall leads to significant improvement on Recall posttest, and that such improvement is significant after one week of test. On the other hand, feedback of recognition is not found to significantly affect the Recognition posttest but did lead to significant improvement on all three Recall posttests, and such improvements were also sustained over the period of one week.

Posttest Comparisons Between Control and Experimental Groups

Data from the Recall posttest 1, 2, and 3, and Recognition posttests 1 and 2 obtained from the experimental group was compared to data obtained from control groups.

The effects of training were analyzed by the chi-square test for independent samples. The outcome of the test showed significant differences occur on Recall posttest 1, 2, and 3, $\chi^2$ (1) = 16.36, $p < .01$, $\chi^2$ (1) = 17.42, $p < .01$, $\chi^2$ (1) = 44.78, $p < .01$, respectively.

No difference was reliable when Recognition posttest 1 and 2 of experimental group were compared to recognition data from control groups.

Data were further analyzed using the Fisher's Exact Probability test (Siegel, 1956) by looking at the "a", "b", "c", and "d" comparisons described above. Significant results were obtained for the effects of recall training on Recall posttests 1, 2, and 3, $p < .01$, $p < .01$, $p < .01$, respectively, and for the effects of training recognition on Recall posttests 1, 2, and 3, $p < .01$, $p < .01$, $p < .01$, respectively. The outcome is substantially the same as the pretest-posttest comparisons reported above.

In sum, results support hypotheses 3 and 4 so far as the effectiveness of training via feedback on Recall posttests. Hypotheses 3 and 4 are not supported for the Recognition posttests. Furthermore, closer inspection reveals that the significant increase on performance in all the instances occurred on day 2, i.e, immediately after the first day of feedback training i.e., there were no significant differences between the recalls on the following days because of the ceiling effect.

A summary of the results pertaining to effects of

training and exposure is provided in Table 3.

Table 1

The Frequency of Responses on Recall and Recognition Pretest

| Recall | N.R. | | PPT | | SQ | |
|---|---|---|---|---|---|---|
| Recognition | +ve* | -ve** | +ve | -ve | +ve | -ve |
| No. of S's | 0 | 2 | 27 | 25 | 7 | 3 |
| Total | 2 (3.1%) | | 52 (81%) | | 10 (19%) | |

Recognition +ve* = Ss who are able to recognize sequences

Recognition -ve** = Ss who are not able to recognize sequences

Recall Frequencies 1973 Data (Kinkaide 1973)

| | No Responses | PPT | Sequential Responses |
|---|---|---|---|
| 1973 Data N = 50 | 7 (14%) | 26 (52%) | 17 (34%) |

Table 2

Recall Tests

Frequency of Sequential Responses Across the Days

for Experimental and Control Group

| | Pretest | Training Day | | | Posttest | | |
|---|---|---|---|---|---|---|---|
| | 1 | 1* | 2* | 3* | 1 | 2 | 3 |
| Experimental Group | 0 | 1 | 9** | 10** | 19 | 23 | 24 |
| Control Group | 0 | 1 | 0** | 3** | 4 | 7 | 2 |

* on days 1, 2, and 3 only 1/2 of the responses are known because only 1/2 of Ss were tested on recall due to experimental design

** the total possible number is 12

Table 3

Frequencies and Probabilities of Ss Showing Successful Performance -
Effects of Training Procedure and Exposure

| | Pretest vs. Posttests Comparison | | | Experimental vs. Control Groups Posttests Comparison | | |
|---|---|---|---|---|---|---|
| | Posttests | | | Posttests | | |
| | 1 | 2 | 3 | 1 | 2 | 3 |
| Effects of Training of Recall | | | | | | |
| on Recall Posttests | 10** | 12** | 12** | 10** | 12** | 12** |
| Recognition Posttests | 9 | 8 | -- | 9 | 8 | -- |
| Effects of Training of Recognition | | | | | | |
| on Recall Posttests | 9** | 11** | 12** | 9** | 11** | 12** |
| Recognition Posttests | 5 | 4 | -- | 5 | 4 | -- |
| Effects of Exposure to Recall Tests | | | | | | |
| on Recall Posttests | 2 | 4 | 1 | 2 | 4 | 1 |
| Recognition Posttests | 2 | 4 | -- | 2 | 4 | -- |
| Effects of Exposure to Recognition Tests | | | | | | |
| on Recall Posttests | 2 | 3 | 1 | 2 | 3 | 1 |
| Recognition Posttests | 7 | 8 | -- | 7 | 8 | -- |

* $p < .05$

** $p < .01$

Table 4

Experimental Group - The Total Number of Actual Events Recalled by Children Through the Experiment

| | Pretest | Training Day | | | Posttest | | |
|---|---|---|---|---|---|---|---|
| | 1 | 1 | 2 | 3 | 1 | 2 | 3 |
| Training through feedback on recognition | 12 | - | - | - | 51 | 64 | 63 |
| Training through feedback on recall | 12 | 12 | 37 | 59 | 68 | 77 | 68 |
| Total | 24 | | | | 119 | 141 | 131 |

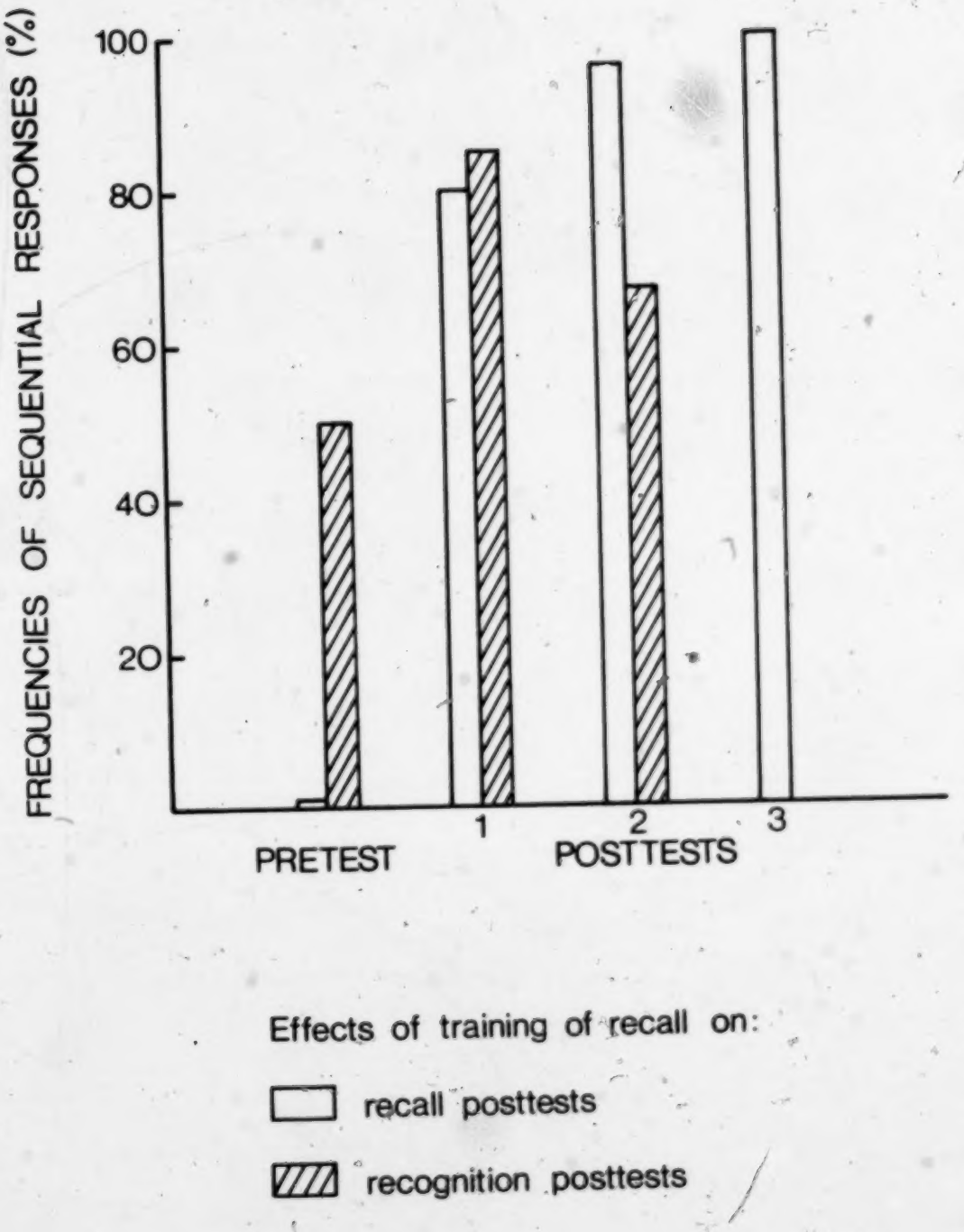


Figure 1. Effects of Training of Recall Through Feedback

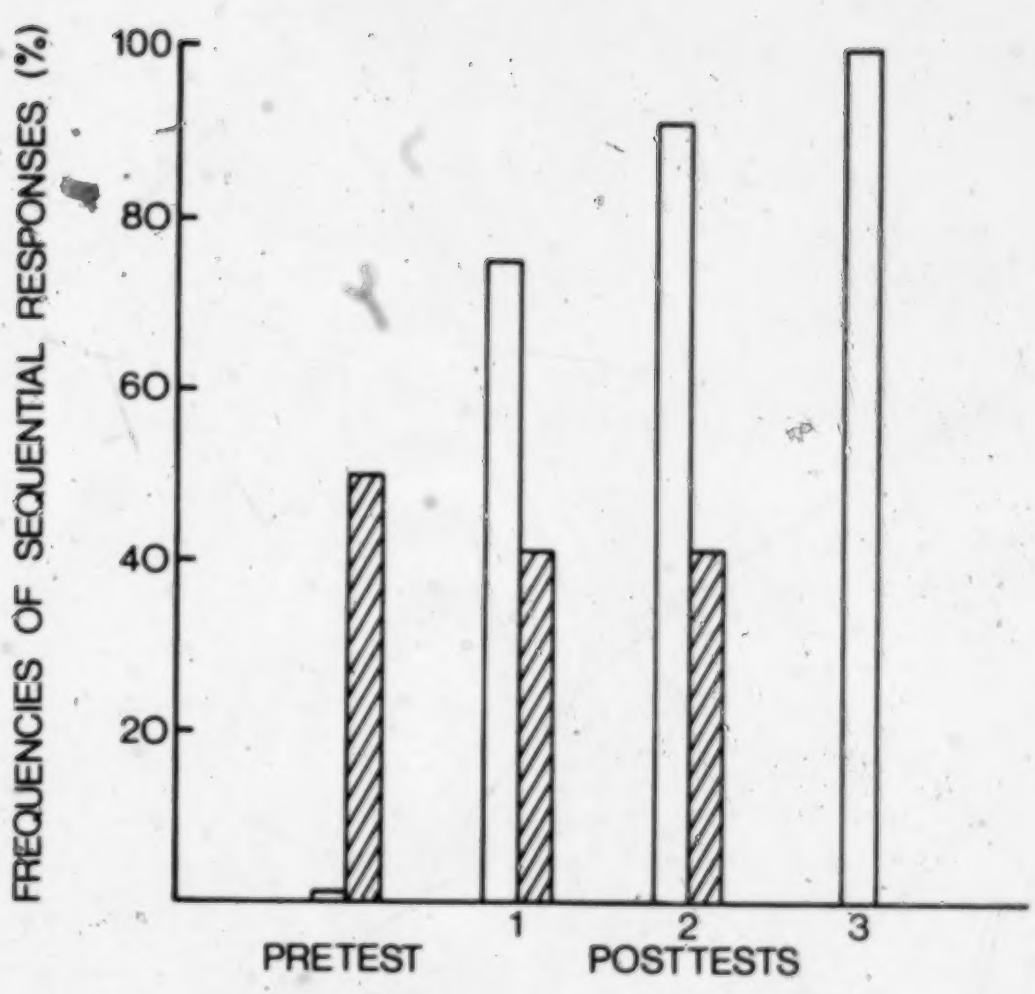


Figure 2. Effects of Training of Recognition Through Feedback

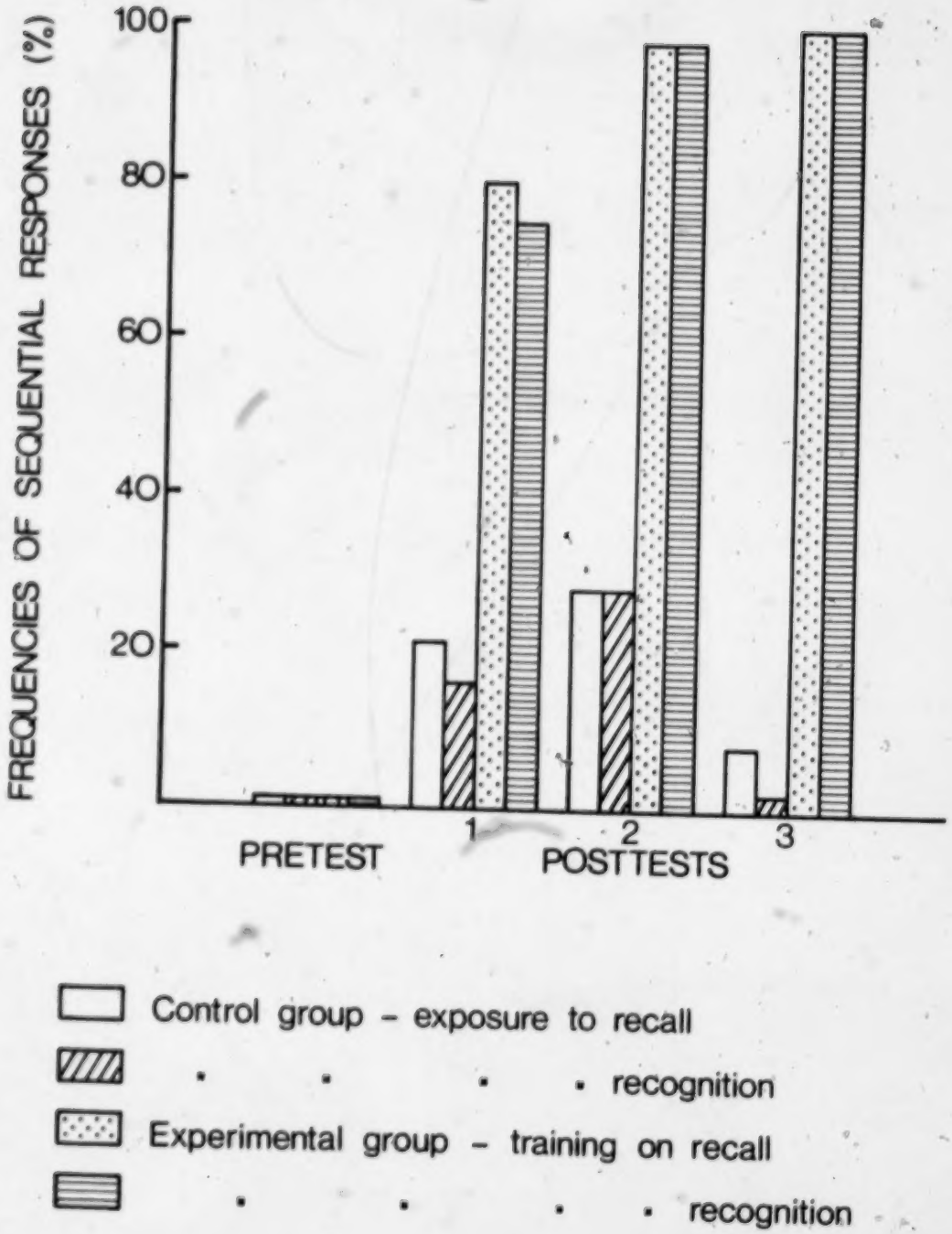


Figure 3. Effects of Training and Exposure on Recall Posttests.

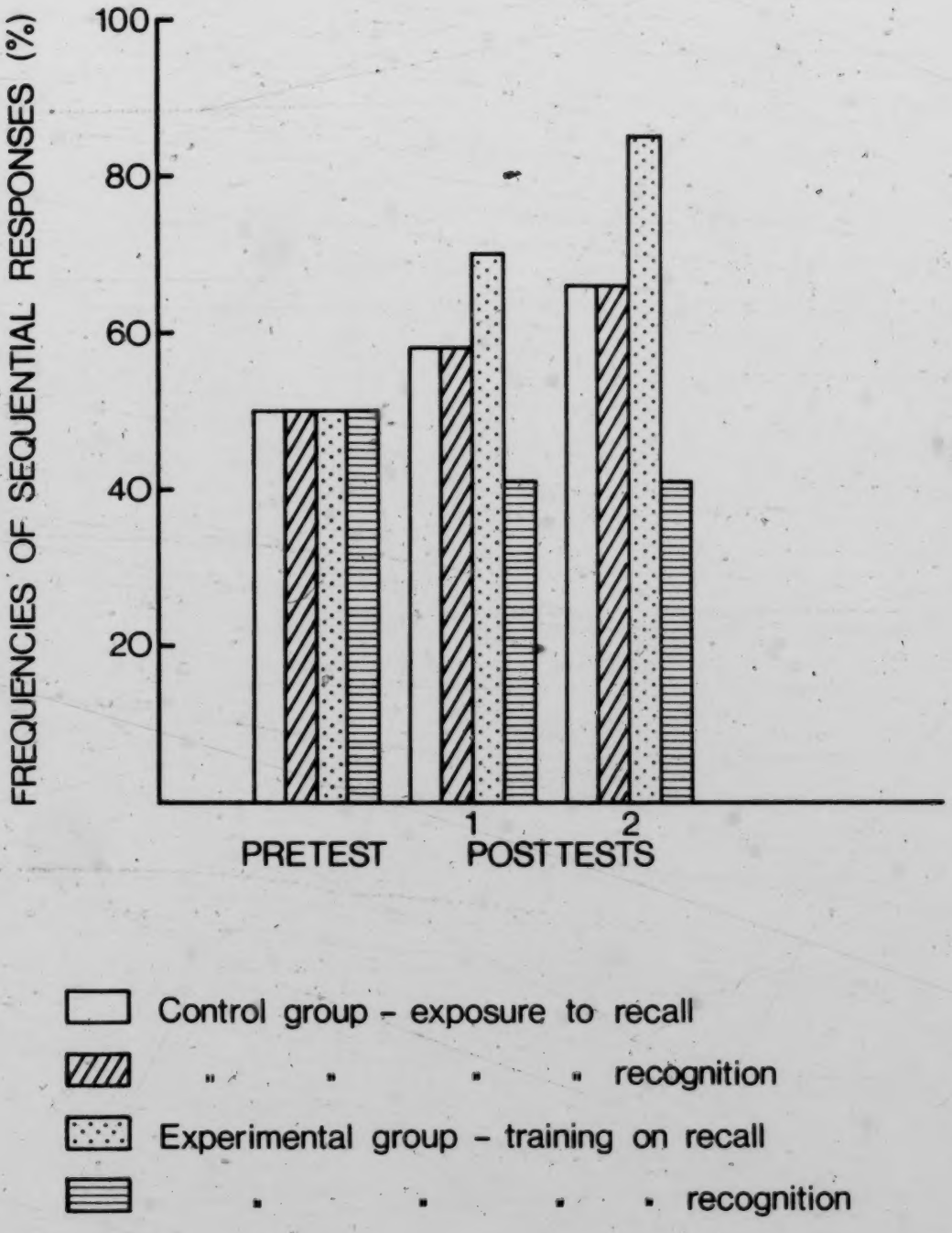


Figure 4. Effects of Training and Exposure on Recognition Posttests

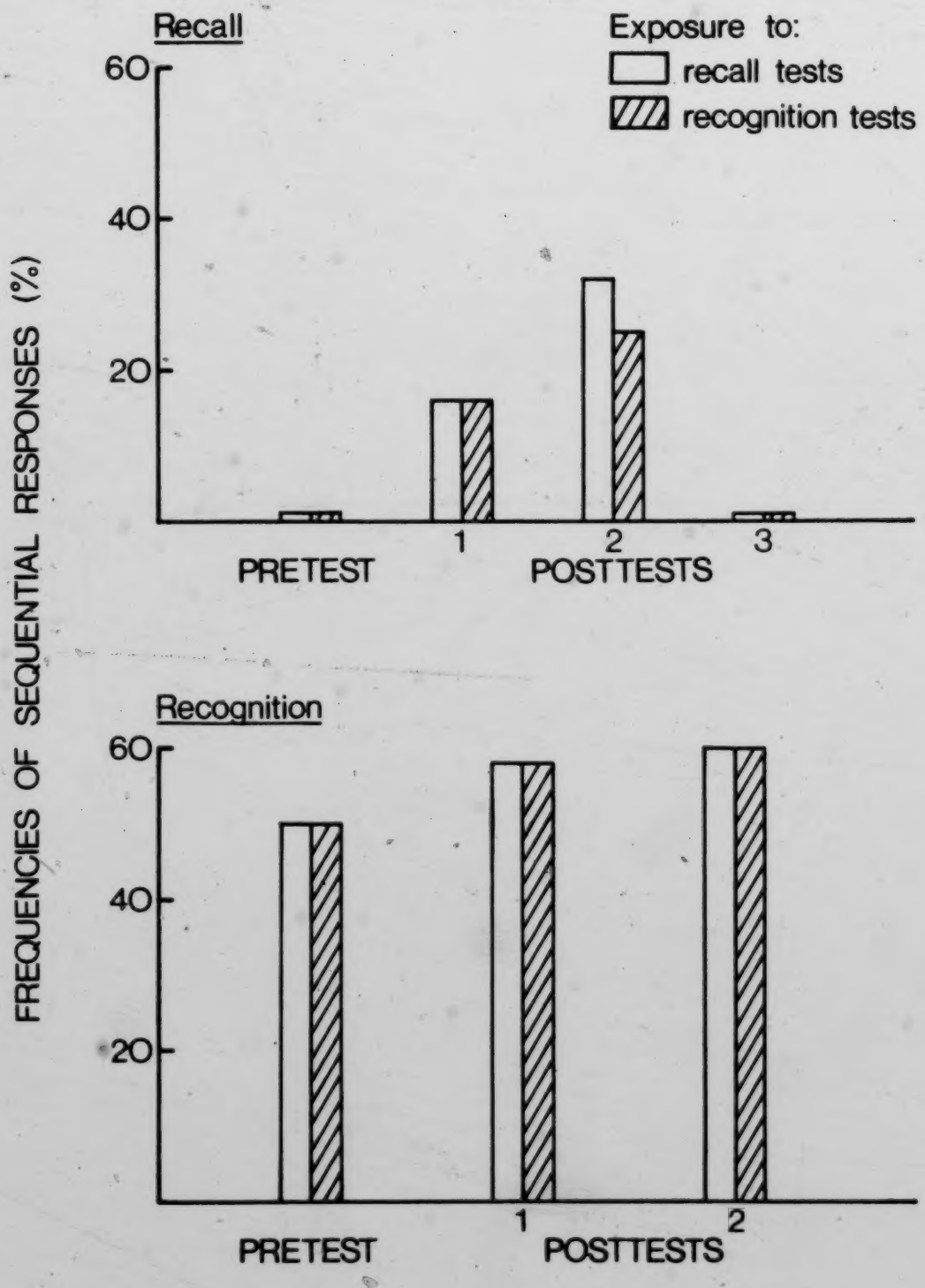


Figure 5. Effects of Exposure on Recall and Recognition Posttests

## V. Discussion

The present study extends those of Kinkaide (1973) and Nelson (1968). It specifically focusses upon how young children spontaneously verbalize notions about temporal events and whether a facilitation of this ability can occur through feedback of relevant cues.

The view that young children's comprehension of time follows a similar sequence as that of primitive man, described by Werner (1946) and Nilsson (1921), was supported in the pretest condition. Seemingly, like a primitive man, most 6-year-old children focus on one concrete event or activity (*pars pro toto*) within the designated interval. Such behavior is present in many instances in their daily lives. Many good illustrations of such an approach to conveying daily events are available, for example, in Sturt's experiments (Sturt, 1925). To take one example only, a child of such age is as likely to describe a season by a single character "it is summer because it is hot" just as a primitive man is likely to structure his experiences according to only one activity filling any given interval.

Turning to the results of the pretest condition, one finds that these are in agreement with conclusions reached by previous research in that they indicate that a majority of 6-year-old children spontaneously recall only one event that has occurred within a given film sequence. The recognition pretest reveals that about one-half of the Ss recognized the correct order of the sequences viewed in the

film implying that children also have registered more understanding of temporal relations than they exhibit in their free verbal recall. Thus, although PPT responses seem to be a natural and spontaneous way for children of this age to respond, obviously it does not mean that they have not perceived at least some sequences. Even a casual observer of 6-year-olds can see that they easily adjust to, and follow, daily and even weekly routines, and appropriately use words which presuppose an understanding of sequential position, e.g., "before" and "after". In addition, the findings on the pretests are in accord with existing literature on memory in children which holds that the development of competent performance on recognition tasks precedes that on recall tasks.

The training condition further explores the stability of pars pro toto responses. Verbal feedback was found to lead to a significant improvement in performance. The overall effects on the recall posttests (1, 2, and 3) demonstrated a reliable improvement on verbal recall of temporal order regardless of whether Ss are trained through feedback on recognition or recall. The visual recognition posttests (1 and 2) alone do not, however, reveal any significant improvement. That is, it made no difference in which form the feedback was given; feedback was not effective in improving performance on the visual recognition test.

Inspection of the data from the recall posttests

indicates that those Ss who showed improvement on posttest 1 sustained an improved performance on posttests 2 and 3. Posttest 2 was administered one week after posttest 1, and during that time the children were not exposed to the films, and test, or to the experimenters. Therefore, performance of the experimental group on the recall posttest 2 is considered a strong indication that the improvement on the verbal recall tasks is robust. The most dramatic and significant improvement in recall followed the first day of training (80% of children improved), suggesting that although most 6-year-old children do not spontaneously structure recall as a temporal order, most can do it quite readily if they know what is to be expected of them.

The use of two training techniques isolated interesting differential effects stemming directly from training itself. The verbal feedback, regardless of whether given through recall or recognition, was consistently most effective on verbal recall tasks. In contrast, the same feedback did not improve performance on recognition tests. Thus in this study, development of the ability to deal with temporal order was facilitated only when verbal recall was required.

Several possible explanations of why visual recognition was not facilitated can be advanced. First of all, underlying processes for recall and recognition are thought to be distinct (Brown, 1975; Halperin, 1974) and thus recognition memory may not be altered by the same verbal training procedure as recall memory. The simplest

explanation may be that both of the training techniques were training verbal performance which is not tapped by the recognition test. If such is the case, the procedures employed in this study are only of benefit to recall.

Pretests actually show that the children did better on recognition than on recall. The requisite ability is therefore present and the lack of positive results on recognition through training may be due to a methodological artifact particular to this study. It may be that success in training for the recognition test was difficult to achieve because it actually required children to do two things successfully: a) recognize three particular scenes from the film, and b) recognize the given order of these particular scenes. Although effects from factor 'a' were possibly reduced since each S was asked if he or she remembered the scenes' films before testing ensued, children were not actually required to prove that they recognized the scenes, and, in fact, some may not have been able to do so. Perhaps a more rigorous way of testing would have been to have Ss pick out the events from the given film to assure that the sequences of events that the children were required to recognize were subjectively important to them. In the interest of improved design, reconstruction of the events chosen by the children on the recognition of items might have been a more appropriate test in this study. These possibilities are yet to be tested however.

This bears directly on the Item 'b' which made the task

more difficult for Ss in comparison with the recall task because it required children to order particular scenes chosen by the experimenter. This means that each child had to deal with items which he or she might, or might not, have found subjectively interesting or relevant. The task the child faced was thus very structured consisting of the two prescribed stages mentioned. Given the general characteristic of this age group, imposing this degree of structure may have made performance disproportionately more difficult for some children.

On the recall tasks, in contrast, credit was given for remembering any two or more of the possible scenes in correct order. This allowed greater freedom of subjective expression and provided less fixed structure to incorporate into response. The fact that the experimental group which was instructed through recognition feedback did improve significantly on the recall posttests (1, 2, and 3) lends credence to this conjecture.

In sum, it is apparent that feedback on visual recognition gave information about the relevant cues, and/or about the concept of temporal order, which was insufficient by itself to improve performance on a subsequent task involving visual recognition of temporal order. The results demonstrate that feedback given through recall or recognition does lead to an increased efficiency of temporal ordering but that this new ability is more difficult to identify in a highly structured recognition task than in a

verbal recall task where the structure is more loose.

The qualitative analysis of responses was not part of this study. However, it is interesting to note that there was a steady improvement of verbal recall as measured by the increasing number of the events recalled by children, especially during the training section of the experiment (Table 4). Many of the Ss gave extended and accurate accounts of the episodes from the film by the end of the study and seemed to improve day by day throughout the testing sessions. Thus, not only did the frequency of SQ responses increase with training but completeness also improved. The exact nature of such qualitative improvements may be interesting to pursue in further research.

It is apparent that temporal ordering of meaningful stimuli is possible for 6-year-old children when, and if, they are aware of what they should be attending to. The fact that the children were not only able to retain the improvement over the period of one week but also were able to generalize it to a novel stimuli strongly suggests that effects from the training procedure go beyond verbal performance and lead to cognitive changes. It may be that performance of the children who lack the specific training the exposure itself, is a reflection of their daily functioning, which means, in the case of the 6-year-old, functioning which is still essentially egocentric and focussed on a particular activity that the child is involved in at any given time.

Results concerning the training effects on verbal recall fit with the findings of recent research in the area of concept learning. As in other studies where significant effects were obtained (Brainerd, 1978) on the training of concept formation, making children aware of the relevant dimension in the given learning task leads to rapid improvement of performance. In the present study, the instructions given were the same for all tested groups and under all conditions. Positive effects, therefore, may be attributed entirely to feedback training. Feedback proved to be effective in training children to relate temporal change, given the qualifications discussed above in regard to the differential effectiveness of feedback on recall and recognition posttests.

These effects are even more impressive when compared to the performance of the control group. The children in the control group were exposed in a standard procedure to the same number of films and were matched to the experimental groups in regard to the tests they received. Results show that exposure to the films and tests was not effective by itself. The majority of control children continued to give pars pro toto responses even after viewing film A for the third time (on posttest 2), and even after having ample experience with the tester, situation, and test questions that followed each film. It might have been expected that knowledge of such questions would provide effective cues as to what the experimenters were looking for. However, even

on already familiar films control Ss retained the pars pro toto form. It would appear that the children did not exchange information in the classroom about their training experiences, or, if they did, that such an exchange did not generalize to the given task.

Results differ from predictions of Piaget's theory in that a significant improvement was achieved through training while experience with the task given through the exposure alone did not lead to a significant change in performance. Piaget's theory stresses the opposite. That is, Piaget suggests cognitive development is a result of self-initiated activities and consequent events. Thus, training procedures are supposed to be successful only when the conditions of spontaneous development are simulated. However, looking at the nature of spontaneous development, one can see that such a condition never really exists in an ordinary child's life where interactions between a child and other people would be totally lacking. In fact, in his daily life the child is constantly corrected about his intuitions and about the different concepts he or she uses or interprets; i.e., the child is often given verbal feedback about whether his intuitions are right or wrong. In this sense, techniques used commonly in laboratory tutorial training studies; e.g., modelling, simple correction, etc., are constantly, if informally, applied to a child in his daily life. Specifically, in the case of temporal order, adults often interpret the temporal aspects of experience, e.g., "You

will get your book after your bath", "First we shall get dressed and then we shall go to the playground", "Daddy left for work", etc. The adults provide the structure in order that the child can reflect on the things that have happened and anticipate the future. There is no reason to believe that if the child were truly left alone with his own resources that he would discover any temporal concepts and particularly the concept of time described by Piaget. Direct research into this area would be, of course, impossible. However, research with deprived children (Dutton, 1967) suggests that their temporal concepts are significantly less well developed than those of middle class children who supposedly get more instructions at home. The results of cross-cultural research also show that the children's concepts do not develop uniformly as Piaget's theory would imply (Brainerd, 1978).

Furthermore, a significant improvement was achieved very quickly after the first feedback, and persisted even after one week of rest. Also, the change generalized to a <u>novel visual stimuli</u> (Film E). The readiness with which the children improved upon the feedback suggests that the children's difficulty in reporting temporal order may depend on a linguistic performance difficulty rather than a cognitive competence difficulty (Siegel, 1978). In any case, the results clearly demonstrate that the preoperational child is capable of benefiting from training focusing upon the concept of temporal order; that is,

performance improvement does not appear to be constrained by the cognitive stage. As was discussed in the introduction, to the degree with which positive effects are achieved on concept formation training tasks, Piaget's theory is weakened.

In the area of temporal memory, Piaget assumes that a preoperational child cannot relate temporal order without perceptual cues being present. He argues that a child's thought is irreversible at that stage of cognitive development; children cannot reconstruct the order of events that have already passed and which are not perceptually available to them. In the present study the majority of 6-year-olds did not spontaneously recall it a temporally ordered way, but those Ss who did recall more than one event did so in the correct temporal order, i.e., they did not jumble accounts as reported by Piaget (1969) and Fraisse (1963). In view of the relative ease with which the children improved through verbal feedback, the difficulty reported by others may be related to the problem the particular recall task presents to children, rather than to difficulty of reporting temporal order per se.

Piaget's experiments have been criticized for presenting children with contrived situations and artificial problems, with which children have little experience. Some research has demonstrated (Gelman, 1969, 1972; Kingsley, 1967; Levin, 1977; Siegler and Lieber, 1972) that even in such unpromising situations children do learn new concepts

if they know which of the many possible cues are relevant to the given task.

The pattern of responses reported here for the experimental groups are basically in agreement with Brown (1975) and Mandler and Johnson (1977). These studies show that memory for order is affected by the nature of the auditory stimuli. The focus of the present study was to investigate children's spontaneous recall of temporal change; i.e., stimuli chosen were viewed as arbitrary representations and approximations of situations that children may encounter in their ordinary lives and which are in that sense generally familiar to this age group. It may be expected that complexity and structure of stimuli will affect the degree to which children do give PPT responses; e.g., certain film stimuli may contain more structural properties which may work to inherently increase attention to the cues relating to temporal order. Speculations about the nature of the events that lead to PPT responses cannot be answered by this study. We must consider that the preoperational child is said to be egocentric, making it difficult to establish which events would make the greatest subjective impression on each individual child. It may be that properties such as novelty, surprise, high tension are likely to be focused on by children.

Data from previous research (Nelson, 1968; Kinkaide, 1973; Nelson and Kinkaide, 1976) provide some information about the stability of PPT responses with regard to thematic

content. These findings suggest that the majority of 6-year-old children retain the PPT responses regardless of the themes in the films, e.g., comedy, war picture, high-tension themes, etc. The question of the stability of PPT responses in relation to various structural content and complexity might be dealt with in further empirical research.

Research with autistic children (Hermelin, 1976) suggests that auditory stimuli are better suited to temporal ordering while visual stimuli lend themselves more readily to processing of spatial dimensions. Consequently, studies of memory for temporal order which make use of auditory stimuli, such as stories, can be expected to lead to more efficient recall of temporal order than if the materials are visual. The present study, and the author's previous research, used visual stimuli exclusively to assess the children's spontaneous functioning in relation to temporal change. In terms of our framework, recall of stories would be expected to contain fewer PPT responses and more sequential responses than films. Although it is at present impossible to make a formal comparison or analysis of this prediction because of methodological differences between studies, data of Mandler and Johnson (1977) based on the recall of stories, appears to contain more complete and ordered recalls. In future research, comparing frequencies of sequential responses to visual and auditory stimuli could be useful in clarifying issues related to temporal

processes.

It is apparent that memory for temporal order is affected not only by properties of stimuli but also by the method by which the children are tested, i.e., recognition, recall or reconstruction. Results obtained from any inquiry into memory for temporal order must be interpreted, giving close considertion to all particulars of stimuli, tests, and procedures. In this sense, one minor contribution of this study is to emphasize the complexity of the processes which must be studied. Notwithstanding this complexity, one major conclusion stands: the cognitive plasticity of preoperational children is greater than traditionally assumed.

The present research, as well as other studies in the area of concept learning (discussed above), have implications for the education of first grade children. Concepts in general, and the concept of time in particular, are not necessarily applied appropriately and spontaneously by children of this age. In this sense they are not established as firmly as they are in adults. However, most concepts which fall within the cognitive scope of the first grade child can be (and educationally, perhaps, should be) situationally altered. The children may need only limited help through instruction to develop these concepts, since they already possess them to some degree. In other cases they can be taught them through specific verbal feedback rather easily. The necessity of directing children's

attention to the relevant features of a given task is evident.

The sequentially ordered instructions are often presented to children at school. This study shows that the children initially do not spontaneously recall tasks in their sequential order. They tend to focus on one part of the sequence only but are capable of recalling sequences if they are made aware that this is expected of them. Thus, it is important for a teacher to realize the children's capabilities as well as what it is about the given task that makes it difficult for the children to perform, or learn, in certain situations.

Furthermore, in the sphere of temporal concepts the children cannot obviously measure duration. Thus, 6-year-old children fail any temporal concept that relies on understanding of durational measurement. Turning to the sequential order, the children must be made aware of what the target concept is, rather than rely on the child's knowledge or self-discovery of it. Making children attend to the relevant dimension (in the case of sequences the necessity to attend to more than one part of a sequence), aided by verbal feedback about the correctness of their responses, proved a potent technique in training children's performance of verbal sequential responses.

## VI. Theoretical Implications

Time is a very complex concept. Because of the diverse manifestations of time, the empirical study of its origins and the developmental acquisition of time concepts may provoke theoretical as well as methodological questions. Psychological interest in the subject is persistent and has lead to different approaches. Results from single inquiries may not bear directly upon important questions which have been asked about time. Consequently, the resulting body of information is not yet unified and is often hard to interpret. As Friedman (1978) summarized: "No single level of analysis described all aspects of psychological time..."(p. 268).

Since there are two separate and essential elements embedded in the concept of time, namely temporal order and duration, separate approaches to these may be useful in providing specific information about basic and developmental components. These two dimensions have to merge before the final concept of logical and conventional time is developed. It is possible that these aspects may develop simultaneously but not interdependently. Traditional research has looked for a fully integrated and basically Newtonian concept of time, one defined by homogeneous, uniform, and everpresent flow, and therefore integrating order and duration completely. In this regard, Piaget, tracing time acquisition, neglects some unique features of children's manifestations of temporal relations at various ages. These

have been discussed through this study, e.g., children's ability to apply appropriate temporal words, anticipate events in the future, relate events from the past. At this point, Ornstein's criticism (1969) of the major approaches to the study of time is relevant. He says: "Some have identified 'real' time with the clock time of minutes, seconds, etc. They forgot that our clock is but one arbitrary means of defining time. It is a convenience, used as an arbitrary standard, useful for meeting and making arrangements. But it is not 'real' time any more than the 'time' of boiling rice is 'real' or cesium time is 'real'" (p. 34).

Independent examination of developmental processes underlying the ability to handle temporal change and duration may extend, clarify, and enrich our understanding of what young children are capable of and sensitive to. It may avert our thinking from emphasizing what they cannot do or comprehend in the sphere of temporal functioning. Developmental research demonstrates that children do exhibit various degrees of ability in their temporal functioning, e.g., use of temporal words, following ordered instructions, using conventional temporal schemes, etc. (Friedman, 1978). The results of this study are in accord with other recent research in the developmental areas of memory for temporal order and conceptual learning, since they strongly suggest that the preoperational child's cognitive capacity is far greater, more flexible and responsive to instruction than

has been traditionally thought. More specifically, in the area of acquisition of time concepts, a good fund of information already exists about how the child's ability to use and understand formal conventional time unfolds. While less is known about the development of antecedents to the concept of formal time and about how these are related to each other, studies of children's use of such temporal words as 'before', 'after', 'and then', 'first of all', indicate that even young children have temporal awareness. This in turn suggests that they also have an understanding of concepts closely related to those of past, present and future, far before they demonstrate such skills within the context of an experimental design (Miller, 1977). The emphasis Miller places on the need for conducting experimental-observational methods, i.e., using materials and situations within children's ordinary experience, is important.

Presently, it appears that before the logical and conventional ideas of time occur, the child may have comprehension of, and skills in dealing with, ongoing change as a temporal dimension. This may be true even when such comprehensions and skills lack integration. It may be said that this spontaneous approach to events of everyday life does gradually lead to experience of durational and formal aspects of time. That is, a child of young age, while lacking conventional and formal temporal understanding, is engaged with and, therefore, does "experience" temporal

order and duration. This is true even though these time dimensions may be independent of each other, and may be vulnerable tc various situational components.

The necessary colligation of temporal order and duration, as studied in depth by Piaget, is indeed a developmental process. The process itself needs to be inspected to see whether it can be accelerated or altered by even earlier training interventions than attempted herein. Presently, we can only believe that 6-year-old children, and conceivably those even younger, are capable of "experiencing" and recalling a great deal more temporal structure than they exhibit in some contrived situations. As Siegel (1978) points out: "...developmental psychologists have concentrated too long and too hard on the problems of what a child cannot do before a certain age instead of asking how a child uses his capabilities, how he can benefit from instructions, and whether the child uses a concept in his or her natural environment. Of course, it does not imply that the child learns about the world around him in a manner analogous to these tasks; it does imply that information about how abilities develop might be gained more fruitfully from the study of the acquisition of concepts than from their presence in the initial state." (p. 62).

Investigation of the accuracy of children's memory for temporal crder per se was not the primary purpose of this study. The interest was rather in children's spontaneous awareness of, and attention tc, ongoing temporal change,

i.e., whether they spontaneously focus on one event embedded in a given sequence of events or whether they attend to and report more than one event. In that sense, sequential responses might have been viewed as any case in which two or more events are related by a child regardless of the actual accuracy of the temporal order. The initial disregard of accuracy in reporting obviously reflects an assumption that attention to more than one event is a prerequisite for reporting of any sequence in a temporally ordered way. In other words, the step following the child's PPT responses would be attending to two or more events and such an attention might not necessarily result immediately in accurate recall of sequences, whatever the final outcome of the process is.

It was somewhat surprising to find that when children recalled more than one event they did so in the correct order. This finding may have been due to the nature of the received feedback in which it was emphasized that the correct temporal order is the relevant cue in the given task. In any case, because stress was placed upon the correctness of the order, it cannot be safely concluded that the children would have spontaneously recalled the correct temporal order without benefit of such intervention. While a firm conclusion is not yet warranted, nonetheless one may conclude that the children were capable of doing so with a minimal training. It may be that a similar experiment with even younger children, and with more emphasis on complete

recall of events and no emphasis on the correctness of the temporal crder, would clarify whether or not children spontaneously and automatically link the remembered events into correct temporal crder or whether they start to structure them in such a manner later. Consequently, questions remain as to the actual developmental sequence of children's spontaneous approach and their efficiency in dealing with events around them which always occur within the context cf conventional temporal dimensions. How PPT responses progress into attention to two or more components of perceived change (at first perhaps reported in incorrect order and finally reported in correct order) cannot be answered by this study. Future research may be expected to provide a more detailed understanding of children's growing capabilities to relate and structure the ongoing change around them.

Werner's suggestion that children's systematization of time does not begin with construction of a continuous, quantitative scheme, but rather with the concept of time as a sort of 'substance' brought together as discontinuous pieces and given structure by concrete and affective qualities, provided an alternative approach to Piaget's. These ideas may be illustrated even in the sophisticated adults who are comfortable with, and knowledgeable about, the convertional temporal schemes used by their society. Adults in our society may frequently resort to PPT responses while reporting about their lives, situations from the past,

and their plans about the future; e.g., one's friend may answer such a question as "what did you do last summer?" by saying "I went to Europe" without any further reference to what had preceded or followed such a trip which also likely did not extend through the entire summer. Such PPT responses are not uncommon in our conversations and indeed are expected, and are probably preferred to long detailed accounts of a person's past and future activities. However, the adult's PPT responses may differ from those of children in at least one way. They may reflect the person's choosing the important feature as an abstraction of the recalled sequence.

Another difference is that adults seem more adept in switching from one mode of relating temporal experiences to another, i.e., PPT, sequential, or multiplesequential. They are not only more ready to do so but also do so more appropriately than children. To give an example, if we ask our spouses about how they specifically spent their day, they can readily tell us about various multisequential activities that they have participated in. A transition from one mode of relating to another cannot be expected of 6-year-old children. Even though children may be capable of relating events in a sequential manner under certain circumstances (and they apparently can be instructed to do so, as this study shows), it does not appear to be their natural or spontaneous way of relating their past experiences or anticipating the future. Furthermore,

notwithstanding the robustness of the training results, the question remains if such improvement would, or did, affect the children's functioning outside of the experimental task.

## References

Achenbach, T. M. Surprise and memory as indices of concrete operational development. Psychological Reports, 1973, 33, 47-57.

Ames, L. B. The development of the sense of time in the young child. The Journal of Genetic Psychology, 1946, 68, 97-125.

Amidon, A., and Carey, P. Why five-year-olds cannot understand before and after. Journal of Verbal Learning and Verbal Behavior, 1972, 11, 417-423.

Arnsdorf, V. E. An investigation of the teaching of chronology in the sixth grade. Journal of Experimental Education, 1961, 29, 307-313.

Barri-Blackley, S. Six-year-olds' understanding of sentences adjoined with time adverbs. Journal of Linguistic Research, 1973, 2, 153-165.

Bateman, B. D. Temporal learning. San Rafael: Dimensions Publishing Co., 1968.

Becker, J. M., and Gonter, K. L. First grade children's understanding of time concepts. Childhood Education, 1966, 42, 389-392.

Benoit, E. P., and Valeno, R. S. Teaching retarded children to tell time. Training School Bulletin, 1962, 59, 22-26.

Bever, T. G. The comprehension of memory of sentences with temporal relations. In J. B. Flores d'Arcais and W. J. Levelt (Eds.), Advances in psycholinguistics.

Amsterdam: North Holland, 1970.

Blackstock, E. G., and King, W. L. Recognition and reconstruction memory for seriation in four and five year olds. Developmental Psychology, 1973, 9, 256-259.

Bohannan, P. Concepts of time among the Tiv of Nigeria. Southwestern Journal of Anthropology, 1953, 9, 251-262.

Bordien, P. The attitude of the Algerian peasant toward time. In J. Pitt-Rivers, (Ed.), Mediterranean countrymen, Tesque: Monton, 1963.

Bradley, B. H., and Hundziak, M. TML-Grolier time telling program for the mentally retarded. Exceptional Children, 1965, 32, 17-20.

Bradley, N. C. The growth of knowledge of time in children of school age. British Journal of Psychology, 1947, 38, 67-78.

Braine, M. D. S., and Shanks, B. L. Conservation of a shape property. Canadian Journal of Psychology, 1965, 19, 197-207.

Brainerd, C. J. Learning research and Piagetian theory. In L. S. Siegel & C. J. Brainerd (Eds.), Alternatives to Piaget: Critical essay on the theory. New York: Academic Press, 1978.

Bromber, W. The meaning of time for children. The American Journal of Orthopsychiatry, 1938, 91, 142-147.

Brown, A. L. Judgement of recency for long sequences of pictures: The absence of a developmental trend. Journal of Experimental Child Psychology, 1973,

473-480.

Brown, A. L. Temporal and contextual cues as discriminative attributes in retardater's recognition memory. Journal of Exceptional Psychology, 1973, 98, 1-13.

Brown, A. L. The development of memory, knowing, knowing about knowing, and knowing how to know. In W. W. Reese (Ed.), Advances in child development and behavior. Volume 10, New York: Academic Press, 1975.

Brown, A. L. Recognition, reconstruction, and recall of narrative sequences by preoperational children. Child Development, 1975, 46, 156-166.

Brown, A. L., and Scott, M. S. Recognition memory for pictures in preschool children. Journal of Exceptional Child Psychology, 1971, 11, 401-412.

Brown, A. L., Smiley, S. S., Day, J. D., Townsend, M. A. R., and Lawton, S. C. Intrusion of a thematic idea in children's comprehension and retention of stories. Child Development, 1977, 48, 1454-1466.

Clark, E. V. How young children describe events in time. In G. B. Flores D'Arcais and W. J. M. Levelt (Eds.), Advances in psycholinguistics. Amsterdam: N. Holland, 1970.

Clark, E. V. What's in a word? In T. E. Moore (Ed.), Cognitive development and the acquisition of language. New York: Academic Press, 1973, 65-111.

Clark, E. V. On the acquisition of the meanings of

"before" and "after". Journal of Verbal Learning and Verbal Behavior, 1971, 10, 266-275 (a).

Clark, H. A. Space, time, semantics, and the child. In T. E. Moore (Ed.), Cognitive development and the acquisition of language, New York: Academic Press, 1973, 27-65.

Cleugh, M. F. Time and its importance in modern thought. New York: Russell and Russell, 1970.

Cole, M., Frankel, F., and Sharp, D. Development of free recall learning in children. Developmental Psychology, 1971, 4, 109-123.

Cottle, T. J. Adolescent perception of time. The effect of age, sex, and social class. Journal of Personality, 1969, 37, 636-650.

Cottle, T. J., and Klineberg, S. L. Developmental perspectives: The present of things future. New York: The Free Press, 1974.

Cromer, R. E. The development of the ability to decenter in time. British Journal of Psychology, 1971, 62, 353-365.

Crowder, A. M., and Hohle, R. H. Time estimation by young children with and without informational feedback. Journal of Experimental Child Psychology, 1970, 10(3), 295-307.

Dutton, W. H. Teaching time concepts to culturally disadvantaged primary-age children. The Arithmetic Teacher, May 1967, 358-364.

Ferreiro, E., and Sinclair, H. Temporal relations in language. International Journal of Psychology, 1971, 6, 39-47.

Flavell, J. H. Concept development. In P. H. Mussen (Ed.), Manual of Child Psychology. New York: John Wiley, Inc., 1970.

Flavell, J. H. The developmental psychology of Jean Piaget. Princeton: Van Nostrand, 1963.

Flavell, J. H. Stage-related properties of cognitive development. Cognitive Psychology, 1971, 2(2), 421-453.

Flavell, J. H. and Wohlwill, J. Formal and functional aspects of cognitive development. In D. Elkin and J. Flavell (Eds.), Studies in cognitive development: Essays in honor of J. Piaget. New York: Oxford University Press, 1969.

Fraisse, P. The Psychology of time. New York: Harper and Row, 1963.

Frankenhauser, M. Estimation of time: An experimental study. London: Almgwist and Wiksell, 1959.

Friedman, K. C., and Marti, V. A. A time comprehension test. Journal of Educational Research, 1945, 39, 62-68.

Friedman, W. J. The development of children's understanding of cyclic aspects of time. Child Development, 1977, 48, 1593-1599.

Friedman, W. J. and Seely, P. The child's acquisition of spatial and temporal word meanings. Child Development, 1976, 47, 1103-1108.

Gay, J., and Cole, M. The new mathematics and an old culture: A study of learning among the kpelle of liberia. New York: Holt, Rinehart, 1967.

Geertz, C. Person, time and conduct in Bali: An essay in cultural analysis. Southeast Asia Studies, Cultural Report Series No. 14. New Haven: Yale University Press, 1966.

Gelman, R. Conservation acquisition: A problem of learning to attend to relevant attributes. Journal of Experimental Child Psychology, 1969, 7, 167-187.

Gelman, R. Logical capacity of very young children: Number invariance rules. Child Development, 1972, 43, 75-90.

Gurvitch, G. The spectrum of social time. Dordrecht: Reidel, 1964.

Hallowell, A. S. Temporal orientation in western civilization and in a preliterate society. American Anthropologist, 1939, 2, 647-654.

Halperin, J. T. Developmental changes in the recall and recognition of categorized word lists. Child Development, 1974, 45, 144-151.

Harner, L. Yesterday and tomorrow: Development of early understanding of the terms. Developmental Psychology, 1975, 11, 860-865.

Harner, L. Children's understanding of linguistic reference to past and future. Journal of Psycholinguistic Research, 1976, in press.

Harrison, M. L. The nature of development of concepts of

time among young children. The Elementary School Journal, March, 1934 pp. 508-514.

Hermelin, B. Coding and the sense modalities. In L. Wing (Ed.), Early childhood autism. New York: Pergamon Press, 1976.

Hermelin, B. M., and O'Connor, N. Children's judgements of duration. British Journal of Psychology, 1971, 62(1), 13-20.

Herriot, P. The comprehension of time in young children. Child Development, 1969, 40, 103-110.

Hirtle, W. H. Time, aspect and the verb. Quebec: Les Presses de L'Universite Laval, 1975.

Kahn, P. Time orientation and reading achievement. Perceptual and Motor Skills, 1965, 21, 157-158.

Kastenbaum, R. The foreshortened life perspective. In W. R. Loft, (Ed.), Developmental psychology: A book of readings. Dryden Press Inc., 1972.

Keeney, T. J., Canizzo, S. F., and Flavell, J. H. Spontaneous and induced verbal rehearsal in recall task. Child Development, 1967, 38, 953-966.

Kelty, M. G. Time expression comprehended by children of the elementary school. Elementary School Journal, March, April, 1925, pp. 523-528; 607-618.

Kinkaide, A. Antecedents of time estimation in children. Unpublished masters thesis, University of Alberta, 1973.

Kintsch, W. On comprehending stories. Paper presented at the Carnegie Symposium on Cognition, May 1976.

Kintsch, W., Kozhinsky, E., Streby, W. J., McKoon, G., and Keenan, J. M. Comprehension and recall of text as a function of content variables. Journal of Verbal Learning and Verbal Behavior, 1975, 14, 196-214.

Klineberg, S. L. Changes in outlook on the future between childhood and adolescence. Journal of Personality and Social Psychology, 1967, 7, 185-193.

Klugman, S. F. Memory for position among children, as measured by serial reproduction. British Journal of Psychology, 1944, 35, 17.

Kobasigawa, A. Utilization of retrieval cues by children in recall. Child Development, 1974, 45, 127-134.

Laurence, M. W. Age differences in performance and subjective organization in free-recall learning of pictorial material. Canadian Journal of Psychology, 1966, 20, 388-399.

Levin, I. The development of time concepts in young children: Reasoning about duration. Child Development, 1977, 48, 435-444.

Levin, J. R., and Vernon, I. A. (Eds.). Cognitive learning in children: Theories and strategies. New York: Academic Press, 1976.

Levi-Strauss, C. The savage mind. New York: Weindenfeld & Nicolson, 1966.

Lewis, M. M. The beginning of reference to past and future in a child's speech. British Journal of Educational Psychology, 1937, 7, 39-56.

Liberty, C., and Ornstein, P. A. Age differences in organization and recall: The effects of training in categorization. Journal of Experimental Child Psychology, 1973, 15, 169-186.

Lloyd, B. B. Perception and cognition: A cross-cultural perspective. Harmondsworth: Penguin Books, 1972.

Lovell, K. and Slater, A. The growth of the concept of time: A comparative study. Journal of Child Psychology and Psychiatry, 1960, 1, 179-190.

MacDonald, B. R. Preposition of time in English. Languages and Linguisitics Working Papers, 1972, 4, 94-110.

Mandler, J. M., and Johnson, N. J. Remembrance of things passed: Story structure and recall. Cognitive Psychology, 1977, 9, 111-151.

Meade, R. D. Psychological time in India and America. Journal of Society Psychology, 1968, 76, 169-174.

Miller, G. A. Spontaneous apprentices: Children and language, New York: The Seabury Press, 1977.

Miller, P. H., Heldmeyer, K. K. Perceptual information in conservation: Effects of screening. Child Development, 1975, 46, 588-592.

Molly, B. E., and Jeffrey, W. E. The effect of organization training on children's free recall of category items. Child Development, 1974, 45, 135-143.

Moynahan, E. D. The development of knowledge concerning the effect of categorization upon free recall. Child

Development, 1973, 44, 238-246.

Neimark, E., Slotnick, N. S., and Ulrich, T. Development of memorization strategies. Developmental Psychology, 1971, 5, 433-439.

Nelson, T. M. Pars-pro-toto in children. Unpublished manuscript, 1968.

Nelson, T. M. and Kinkaide, A. Pars-pro-toto responses to films of different thematic content. Unpublished manuscript, 1976.

Oakden, E. C., and Sturt, M. The development of the knowledge of time in children. British Journal of Psychology, 1922, 12, 309-366.

Orme, J. E. Time, experience and behavior. London: Iliffe Books Ltd., 1969.

Ornstein, R. E. On the experience of time. Harmonsworth: Penguin Books, 1969.

Osmond, H. Introduction: The future of time. In H. Yaker, H. Osmond, and F. Cheek (Eds.), New York: Anchor Books, Doubleday, 1972.

Piaget, J. The child's conception of time. New York: Basic Books, 1969.

Piaget, J. Genetic epistemology. New York: Norton, 1970.

Pick, A. D., Frankel, D. G., and Hess, V. L. Children's attention: The development of selectivity. In E. M. Hetherington (Ed.), Review of child development research (Vol. 5). New York: Anchor Books, 1976.

Pistor, F. Measuring the time concepts of children.

Journal of Educational Psychology, 1939, 33, 293-300.

Pufall, P. B. and Furth, H. G. Recognition and learning of visual sequences in young children. Child Development, 1966, 37, 827-836.

Ritter, K., Kaprone, B. H., Fitch, J. P., and Flavell, J. H. The development of retrieval strategies in young children. Cognitive Psychology, 1973, 5, 310-321.

Rossi, E. L., and Rossi, S. I. Conceptualization, serial order and recall in nursery school children. Child Development, 1965, 36, 771-778.

Schechter, L. E., Symonds, M., and Bernstein, T. Development of the concept of time in children. Journal of Mental Disease, 1955, 21, 301.

Shannon, L. Development of time perspective in three cultural groups. A cultural difference or an expectancy interpretation. Developmental Psychology, 1975, 11(11), 114-115.

Shapiro, S. T., and Molly, B. E. Free recall, subjective organization and learning to learn at three age levels. Psychonomic Science, 1971, 23, 189-191.

Siegel, L. S. The relationship of language and thought in the preoperational child: A reconsideration of nonverbal alternatives of Piagetian tasks. In L. S. Siegel and C. J. Brainerd (Eds.), Alternatives to Piaget: A critical essays on the theory. New York: Academic Press, 1978.

Siegler, R. S., and Liebert, R. M. Effects of presenting

relevant rules and complete feedback on the conservation of liquid quantity task. Developmental Psychology, 1972, (a) 7, 133-138.

Siegler, R. S., and Liebert, R. M. Leaning on liquid quantity relationships as a function of rules and feedback, number of training problems, and age of subjects. Proceedings of the 80th Annual Convention of the American Psychological Association, 1972 (b), 7, 117-118.

Sinclair-de Zwart, H. Language and cognitive development. In T. E. Moore (Ed.), Cognitive development and the acquisition of language. New York: Academic Press, 1973.

Stevenson, H. W. Children's learning. New York: Meredith Corporation, 1972.

Stone, D. E. Growth in the understanding of time concepts. Dissertation Abstracts International, 1971, 32 (4-4), 1961.

Sturt, M. The psychology of time, London: Kegan Paul, 1925.

Uka, N. The development of time concepts in African children of primary school age. Ibadan: Institute of Education, 1962.

Walach, L., Wall, A. J., and Anderson, L. Number conservation: The roles of reversibility, addition-subtraction, and misleading perceptual cues. Child Development, 1967, 38, 425-442.

Wallace, M. and Rabin, A. S. Temporal experience.

Psychological Bulletin, 1960, 57, 213-236.

Weil, J. The relationships between time conceptualisation and time language in young children. Unpublished doctoral dissertation, The City University of New York, 1969.

Woodrow, H. Time perception. In S. S. Stevens (Ed.), Handbook of Experimental Psychology. New York: Wiley, 1951.

Zelkind, I. Time research. New York: Scarecrow Press, 1974.

Zern, D. The influence of certain child-rearing factors upon the development of a structured and salient sense of time. Genetic Psychology Monograph, 1970, 81, 197-254.